Gas Journal

MAY 26, 1937

Vol. 218 89th Year No. 3862

Editorial Notes

Smoke Abatement

In our news columns last week there was a sad little paragraph recording the decision of the Blackburn Town Council to employ coal-fired boilers for heating their new and highly expensive central baths. Actually the recommendation of the Baths Committee to use coal was challenged at the Council meeting in April and was referred back by a large majority, with a view to gas being fully considered. The Committee, undaunted, reaffirmed their previous recommendation, and though this was further challenged at the Council Meeting in May, advocates of a purer atmosphere lost the day. This is particularly unfortunate just at a time when the work of the smoke abatement movement is beginning to show fruitful results throughout the country. Published last week by the Department of Scientific and Industrial Research was the 22nd Report on Investigation of Atmospheric Pollution, in which a review is made of the state of the atmosphere during recent years. Measurements of pollution are carried out by 72 municipal and other bodies—Blackburn is not among them—which co-operate with the Department in this work; and in the report the mass of data now available, some of which goes back to 1915, is analyzed. The results, it is stated, "indicate definite ground for belief that the smoke abatement movement has had a real effect." Naturally the position in recent years must have been markedly affected by the great industrial depression of 1930-33; but the outstanding feature of the analysis is the large decrease in pollution occurring at many places before the industrial depression set in.

The report demonstrates what can be accomplished by communities which make real attempts to rid the atmosphere of pollution. Burnley provides a good example. This municipality shows a remarkable drop in the amount of deposit between 1927-28 and the present time—the total solids deposited at the Town Hall station have been reduced from 850 to 450 tons per square mile. The Burnley public baths, it may be mentioned, are "all gas." Plunge baths, slipper baths, and showers—all heated by gas. No trouble due to faulty stoking, no dirt—an important consideration where bathing is concerned—no wastage of space, no fear of failure. And the system has proved to provide economy, with all these and other advantages, including, of course, absence of air pollution. Leicester is another municipality showing a decrease in atmospheric pollution. There the heating of the Town Hall, Corn Exchange, and other public buildings is done by gas.

Smokeless Zones

There is a public awakening to the need for smoke abatement, but, as we have emphasized before, much more general effort should be put forward to eliminate the nuisance, and the Smoke Abatement Society is deserving of greater support. The Society is untiring in its efforts and has been responsible for considerable improvement and many useful suggestions as to the lines along which further improvement might well be made. In this connection the suggestions contained in a recent Paper prepared by three members of the Society are much to the point. The conclusion arrived at in that Paper is that an effective method of controlling smoke from non-industrial premises would be the establishment of smokeless zones—well defined areas to be specified and controlled by by-laws. Certain city areas should be cleared of smoke; and the same principle, they maintain, could be applied to other selected areas, such as in the vicinity of hospitals, aerodromes, important architectural monuments—and, we would add, town halls. Certainly the adoption of smokeless methods by its leading citizens and the possibility of being able to walk through an area without seeing a single smoking chimney would be of the greatest value as an example to others in the city. As the defining of the areas to which the suggested regulation could apply must be a local matter it is clear that the legislation necessary would be of a permissive character, enabling local authorities to make by-laws applicable in the specified areas. This idea of zoning appeals to us as a first step towards smokeless cities, and surely those who are paying for the privilege of occupying premises on expensive sites and themselves use smokeless fuels are entitled to be protected, as far as possible, by the placing of such a restriction on their immediate neighbours.

Industrial Smoke

THIS question of the pollution of the atmosphere by smoke is dealt with at some length by Mr. W. A. Damon, Chief Alkali Inspector for England and Wales, in his annual report for 1936, and the matter is also referred to by Dr. Birkett Wylam, Chief Alkali Inspector for Scotland. While Mr. Damon notes with satisfaction that there has been some abatement of domestic smoke in recent years due to the increasing use of gas and other smokeless fuels, he maintains, as he has maintained in previous reports, that the greater use of such fuels should be encouraged and thinks that the time will come when the burning of raw coal will not only be regarded as an offence against public amenities but will be prohibited on economic grounds. As regards industrial smoke, his observations have shown that there has been deplorably little progress except in those districts where cheap gas and electricity are available. Cheap gas has, of course, been the major factor, and doubtless extension of the use of coke oven gas where circumstances permit will help matters in the future. There exists a great field for development in this direction. Quite apart from initial fuel cost, however, manufacturers as a whole do not yet fully appreciate the advantages of gas from the points of view of ease of control, cleanliness, saving in labour and space, and elimination of wastage in processes of manufacture. We have still a lot of spade work to do in the way of propaganda and demonstration to make industrialists think in terms of over-all costs of the product rather than to compare fuel bills alone.

Naturally we welcome Mr. Damon's advocacy of the greater use of gas and other smokeless fuels. We also welcome the remarks of Mr. John Cadman, whose chief interest lies in the coal industry, at the Lord Mayor of Stoke-on-Trent's Coronation luncheon. It will not be long, he said, before the principal salesmen for coal will be gas and electricity undertakings by converting coal into heat and power. He referred to the strides made by the Stoke-on-Trent Gas Department in the furtherance of gas for pottery firing, and in doing so paid tribute to Mr. A. Mackay. Smoke emission is still high in the Potteries, however, a matter to which Mr. Damon calls attention in his report, pointing to the great desirability of employing gas, which has proved so eminently satisfactory.

It is only fair to record that, on this question of smoke pollution, Mr. Damon does not hold the producers of smokeless fuels entirely free from blame. He has in previous reports had occasion to complain, and in no uncertain terms, of the escape of " green " gas during the charging of coke ovens. His references to the subject have been frequent, but, with a few notable exceptions, there has been very little improvement. Old installations are being replaced, but the opportunity of securing improvement is being lost. There is, of course, no need for this escape, as is exemplified among other plants by the coke oven installation at the Beckton Works of the Gas Light and Coke Company.

In regard to sulphate of ammonia, the Alkali Report records substantial increase in production from gas-works liquors in 1936 and also a considerable increase in the production of concentrated liquor—a policy we have long advocated in these columns. The process is easy to operate for any size of works, and by this means the carriage costs are reduced so that it is practicable to transport the concentrate to a central plant where it can be worked up at a profit. As for tar, the reports of the Chief Inspectors of Alkali record a very good demand for lighter tar oils and creosote, together with a poor pitch market. Statistics from the Alkali Report are given on a later page.

Advances in America

THE American Gas Association has issued a statistical report covering the activities of the American Gas Industry during the years 1929 to 1936; and it is obvious from the figures that the Industry, as a result of redoubled efforts in a period of intense industrial depression, is emerging successfully and can confidently anticipate widespread expansion now that times are better. We have called attention before now to the clear way in which the American Gas Industry presents its returns. The industrial and commercial loads are shown distinctly separate from the domestic load, which renders easier analysis of the trends. It is a plan which we should do well to follow. The Industry is, of course, a composite of manufactured gas and natural gas undertakings, and actually the manufactured side is of less magnitude than the British Gas Industry. Of recent years a drive has been made to secure what is termed the " house heating " load, and in the case of the manufactured gas side, the side with which comparisons can be made with this country, the number of " house heating " consumers has increased by 142% during the period covered by the A.G.A. statistics. Total domestic consumers have increased by 3·3%, but this growth has been coupled with a decline in domestic sales of 8·5% and in revenue of 6·6%.

Since 1932, however, which marked the depth of the slump, the curve of consumption has been on the upgrade, and everything points to an accelerated rate of progress during the present year. The American Gas Industry is also concentrating on the water-heating and refrigeration loads and is now beginning to feel the effects of campaigns on a scale far greater than has previously been attempted. The water heating load, as we have long maintained, offers in itself a solution to the increased consumption per consumer problem. The possibilities are enormous, and the load can be gained by affording full facilities for the acquisition of water heating appliances and offering attractive promotional rates for gas consumed. It seems clear that the future of the Gas Industry both in America and in this country will depend on selling greater quantities of gas at a lower marginal profit per therm, spreading overheads over a larger volume of business, and improving the load factor.

The bearing of the price of gas on business gained is brought out by the American statistics. Of the natural gas business domestic and " house heating " account for 57% of the total sales, while the corresponding figure for the manufactured gas side of the Industry is 80%. In this country the Sheffield Gas Company is an outstanding example of an undertaking which, able to sell gas to industry at low rates, is going ahead at a truly remarkable rate with the industrial load. This vast expansion, however, is not due solely to cheap gas; it is the result of cheap gas *plus* first-class service. The application of gas to all manner of heat treatment processes has been made possible only by research work carried to a successful conclusion by the Sheffield Company and other gas undertakings. Research, too, has played a major rôle in the development of the industrial gas load by the American Gas Industry on both the natural gas and the manufactured gas sides. We have mentioned that since 1929

there has been a decline in the domestic sales by the manufactured gas side of 8·5%. The total sales have during this period, however, fallen by only 3·1%. This is another indication that for many purposes gas can be sold to industry at rates per therm considerably in excess of cruder fuels. The fact remains, though, that our competitors are by no means standing still. Modern solid fuel fired furnaces, for example, are vastly superior to their predecessors, and in many instances they produce excellent work. Thus when approaching an industrial proposition it becomes of increasing importance that any comparisons between fuel costs should take into consideration improvements in economy and technique effected by competing fuels. It is not enough to explain to an industrialist that the displacement of his existing furnaces by gas equipment will result in a certain saving to him. Real satisfaction in the salesman's mind can only exist if he knows that his proposition is sound in that it can bear favourable comparison with the modern appliances of competing industries.

Correspondence

"The Science and Practice of Gas Supply"

SIR,—All members of the British Commercial Gas Association will have received a communication in connection with the proposed publication of the third volume of "The Science and Practice of Gas Supply." We are asked to indicate whether or not we will purchase one copy each, and what further copies at a reduced price will be required.

As one who has taken a great interest in this work, I wish strongly to urge that all gas engineers and managers should treat this communication very seriously. In my opinion the three volumes published by the British Commercial Gas Association fill a long-felt want. The education and training of juniors in the science and practice of gas supply is so fundamental to the future success of the Industry that when an entirely adequate and reliable treatise becomes available it will pay the Industry to see that every junior on this side of our business is supplied, free if necessary, with this publication. It is more than a cramming book; it is a complete book of reference, and can be looked on as a published correspondence course on the subject.

It would be a pity, through lack of appreciation of the facilities that are available, if the fullest use is not made of Mr. Coe's work.

Yours, &c.,
E. W. SMITH.

Ebury and Allington Houses,
136-150, *Victoria Street, S.W.* 1.
May 21, 1937.

Personal

Coronation Medals.

Since recording last week the presentation of the Coronation Medal to Mr. F. G. Shaw, we learn the following are also among the recipients of that honour: Mr. H. L. BATEMAN, Engineer and Manager, Dewsbury Gas Department; Mr. D. WALTER DAVIES, Engineer and Manager, Tredegar Urban District Council Gas and Water Department; Mr. JAMES DICKSON, Engineer and Manager, Kirkintilloch Gas Department; Mr. JAMES N. LECKIE, Engineer and Manager, Windermere Urban District Gas and Water Department; and Mr. JOE SADLER, The Parkinson Stove Company.

* * *

Standing as a Conservative, Mr. E. T. WARREN has been elected to the Watford Borough Council in a by-election in the Casiobury Ward. Mr. Warren is Assistant Secretary of the Watford and St. Albans Gas Company and of its various welfare schemes.

* * *

Two members of the staff of the Cannon Iron Foundries, Ltd., Deepfields, Bilston, Mr. JAMES W. WRIGHT, Sales Manager in the Chemical Plant and Sanitary Departments, and Mr. WILLIAM CADDICK, of the Sales Office, have just completed 50 years each in the service of the Company.

To mark this event, each has been presented by the Directors with a solid silver salver having a suitable inscription, together with facsimile signatures of the Company's five Directors.

* * *

Mr. JAMES KINCAID, who, as we announced last week, has retired from the position of Engineer and Manager at Kirkcaldy, was on May 19 entertained at luncheon in the North British Station Hotel, Edinburgh, by some of his former assistants, on whose behalf Mr. Henry Rule, formerly on the Falkirk staff and now on the commercial side of the Industry, presented Mr. Kincaid with a gold inlaid cigarette box. Mr. H. G. Ritchie, Engineer and Manager, Falkirk, presided, appreciative references to Mr. Kincaid being made also by Mr. H. A. Aitken, Leven, and Mr. David Morton, Arbroath. Among those who have served under Mr. Kincaid, in addition to those already mentioned, are Messrs. Alexander Dow, Galashiels; F. A. West, Altrincham; H. Matterface, Monmouth; John Ireland, Carnoustie; R. J. Gavin Melrose; B. Marshall, Kinghorn; Annan Galloway, Auchtermuchty; and John Keillor, Vancouver.

Obituary

The death took place on Thursday last of Mr. CHARLES HENRY COWLISHAW, Chairman of the Uttoxeter Gas-Works, Ltd.

Forthcoming Engagements

May.

27.—B.C.G.A.—Manchester District Conference at Oldham.
27.—WALES AND MONMOUTHSHIRE ASSOCIATION.—Annual Meeting at Cardiff.

June.

1-4.—I.G.E.—74th Annual General Meeting, Royal Geographical Society Hall, Exhibition Road, Kensington, S.W. 7.
7.—W.G.C.—Executive Committee Meeting, 2.30 p.m.
9.—COKE SALESMEN'S CIRCLE.—Visit to Crane, Ltd., Ipswich.
9.—ASSOCIATION OF STATUTORY INSPECTORS OF GAS METERS.—Annual General Meeting, County Hall, Westminster Bridge, 10 a.m. Visits to the Gas Meter Testing Office, Kennington, and Smith Meters, Ltd., Streatham.
10.—ASSOCIATION OF STATUTORY INSPECTORS OF GAS METERS.—Visit to Beckton, 2.30 p.m., preceded by lunch at the Town Hall, Barking.
17.—S.B.G.I.—Council Meeting, 56, Victoria Street, S.W. 1, 11.30 a.m.
18.—I.G.E.—Special Council Meeting, 2.30 p.m.
18.—NORTH OF ENGLAND ASSOCIATION (AUXILIARY).—Meeting at Middlesbrough.
18.—WAVERLEY ASSOCIATION.—Annual Meeting at Edinburgh.
19.—LONDON AND SOUTHERN JUNIORS.—Summer Visit to Luton.
23.—I.G.E.—Pipe Committee, 3 p.m.
24.—SOUTHERN ASSOCIATION (EASTERN DISTRICT).—County Meeting at Luton.
25.—I.G.E.—Joint Lighting Committee, 2.30 p.m.
25.—B.C.G.A.—Scottish Conference at Peebles Hydropathic.

July.

2.—I.G.E.—Joint Committee on Complete Gasification under Pressure, Department of Scientific and Industrial Research, 16, Old Queen Street, S.W. 1, 3 p.m.
9.—SOUTHERN ASSOCIATION.—Summer Meeting at Southampton.
13.—I.G.E.—Council, 10 a.m.
15.—I.G.E.—Gasholder Committee, 2.30 p.m.

News in Brief

The Lighting of an additional 4½ miles of class "E" main road by overhead units has been secured by the Dewsbury Gas Department. Over 95% of the street lighting of Dewsbury is by gas.

The London Agency of Det Danske Gaskompagni will be situated as from to-day's date (May 26) at 34, Victoria Street, Westminster, S.W. 1. The new 'phone number is Victoria 7304 and telegraphic address—"Gasholder, Sowest, London."

A Wonder Home Gas Exhibition is being held on May 26, 28, and 29 at Holdrons, Rye Lane, S.E., in conjunction with the South Metropolitan Gas Company, at which the National Milk Publicity Council are giving a series of special milk cookery demonstrations which should be of considerable interest to local housewives judging by the comprehensive programme that has been arranged.

The Proposed Exhibition of Modern Architecture by the Mars Group has aroused wide interest, in consequence of which the organizers have decided to enlarge its scope considerably. As this necessitates extensive structural changes to the New Burlington Galleries, where the exhibition will take place, the opening is postponed until October. The exhibition organizer is Mr. M. B. Bradshaw, 3-5, Burlington Gardens, Old Bond Street, W. 1.

A Programme of Films produced by the Gas Light and Coke Company was recently shown by the Hampton Court Gas Company before 100 members of the Teddington and Hampton Women Citizens' Association. During an interval refreshments were served, and at the conclusion, Councillor Mrs. Raymond Taylor, a member of the Women Citizens' Association, conveyed to Mr. C. T. Price (Engineer and Manager) and the Company their thanks for an educative and interesting evening.

A Move to Discontinue the showrooms of the Dundee Gas Department in Broughty Ferry, which were badly damaged by an explosion some weeks ago, was initiated by Treasurer Kidd on May 17. Mr. John Wilson, Engineer and Manager, reported that the cost of reconstruction would not exceed £1,000. The Treasurer asked whether they needed such a building in Broughty after putting up such expensive premises in Dundee. A subcommittee is to confer with the Engineer and Manager.

A Triple Success was scored by the Ludlow Union Gas Company when in the Coronation carnival procession their entry in the decorated trade vehicle class won first prize; the Works Superintendent was awarded first prize in the individual fancy dress section; and in a window dressing competition organized by the Ludlow and District Chamber of Commerce the Company's showroom windows were placed first. Throughout Coronation week the famous old "Black and White" Angel Hotel was floodlighted by gas and attracted much attention and favourable comment.

A Large Decorated Iced Cake, which has been greatly admired by a large number of people passing the Folkestone Gas Company's showrooms, in Rendezvous Street, has, together with a cheque for £105, been presented to Mr. F. T. Wilton, the Secretary-Superintendent of the Royal Victoria Hospital. The presentation by Mr. G. le B. Diamond, Engineer and General Manager, took place in the women's surgical ward of the hospital in the presence of the Matron, Mr. F. B. Hemsley, Secretary of the Folkestone Company, Miss Marie Edwards, the Company's demonstrator, Mr. R. Waddup, Secretary of the Gas Company's Sick and Dividend Club, and members of the nursing staff of the hospital.

Pieces of Eight!

While a workman was carrying out repairs at the Llandovery Gas-Works he struck a china cup embedded in a wall. The cup broke and, to his amazement, a large number of gold and silver coins fell out. On examination they proved to be sovereigns, half-sovereigns, and silver coins of the Victorian period to the currency value of £17 2s. 6d. The discovery was notified to the police and in accordance with regulations governing treasure trove the Coroner will hold an inquest on the discovery on June 1.

CURRENT EVENTS IN THE GAS INDUSTRY

Amalgamation and Grouping

Pontypool and Cwmbran and Pontnewydd.

We learn that the Pontypool Gas and Water Company have acquired the Undertaking of the Cwmbran and Pontnewydd Gas Company, Ltd.

South-Western and Glastonbury.

An offer has been made by the South-Western Gas and Water Corporation to purchase the Gas Undertaking of the Glastonbury Town Council for the sum of £60,000. The Gas Committee and the Finance Committee have recommended the acceptance of the offer subject to expert advice.

Tottenham Standard Price Unaltered

Middlesex County Council's Application Rejected

The Board of Trade has now given its decision on the application by the Middlesex County Council for a further revision of the standard price of the Tottenham and District Gas Company. This price has not been altered at this time.

The standard price as fixed under the Tottenham Gas (Charges) Amending Order, 1925, is 13·8d. per therm.

An enquiry was held at the offices of the Board of Trade on Jan. 26, 27, and 28, 1937.

South Metropolitan Company's Gas Sign

Reference was made in the "JOURNAL" for April 7 to the new type of ornamental gas sign introduced by the South Metropolitan Gas Company. Above we see the sign in operation on the Company's Lewisham Showrooms. The Crown and Royal Monogram consisted of 300 of the small special mantles, and the whole produced a candle-power in excess of 20,000.

Institution of Gas Engineers

Membership

The Secretary of The Institution of Gas Engineers announces that the following membership Transferences and Elections to Studentship have been effected in accordance with the Royal Charter and By-Laws:

Transferred from Associate Membership to Membership:

LOCKHART, Thomas Spring, Engineer and Manager, Burgh of Rothesay Gas Department, Bute.

Transferred from Associateship to Associate Membership:

KEILLOR, Henry Graham, Junior Assistant, Greenock Corporation Gas Department, Renfrewshire.

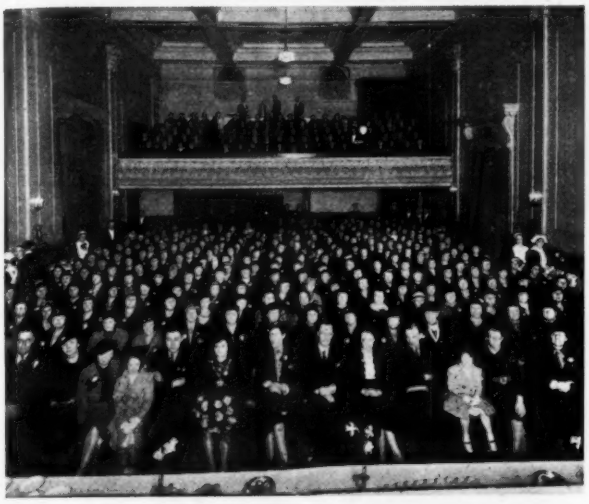
PLUMMER, Ronald George, B.Sc., an Assistant Engineer, Southall Station, The Gas Light and Coke Company, Middlesex.

Women's Gas Council

Manchester Branch Entertained by Ascot's

On Wednesday, May 5, at the Lesser Free Trade Hall, Peter Street, Manchester, Ascot Gas Water Heaters, Ltd., entertained 450 members of the Manchester Branch of the Women's Gas Council.

The opening ceremony of this entertainment was performed by the Lady Mayoress of Manchester (Mrs. J. Toole), who read a telegram of good wishes sent by Dr. B. Friedman (Managing Director of Ascot Gas Water Heaters, Ltd.) and was afterwards presented with a bouquet of roses. Mr. T. B. V. Hirst (Assistant Chief Technical Engineer of the firm) then gave an interesting and instructive Address on " Water Heating by Gas."



Ices were subsequently served, and the first of the " Surprise Items " introduced. This consisted of a delightful mannequin parade of Coronation Hairdressing, in which eight professional mannequins were introduced displaying the latest hairdressing styles. Next followed a draw for free seats at various Manchester cinemas which caused great excitement. As the next item, Mr. Teddy Joyce and his " Girl Friends " were introduced and provided an excellent programme of dance and novelty numbers, and also several speciality acts by a dancer singer, and saxophone solo, followed by acrobatic dancing by Mr. Joyce.

After the " Surprise Items " the screen was lowered and the programme resumed with the showing of the B.C.G.A. films—" Nutrition," " Getting into Hot Water," and " The Man who knew too Little," which were very well received.

Tea was afterwards provided, and every member of the audience was given a cream rose as a buttonhole. The whole entertainment was thoroughly appreciated and was considerably helped by the excellent stage, scenic, and lighting effects available at the Hall.

Bradford Visit Wilsons & Mathiesons, Ltd.

The Bradford Branch of the Women's Gas Council paid a visit to the Works of Messrs. Wilsons & Mathiesons, Ltd. (Radiation Ltd.), at Armley, on May 20. Mr. J. R. Firth, of the Bradford Corporation Gas Department, was in charge of the party, the Members of the Committee, Mrs. N. Cunningham (Chairman), Mrs. F. Sunderland (Vice-Chairman), Mrs. Firth (Hon. Secretary), and Miss Hart (Hon. Treasurer) also being present.

A tour was made of the departments, particularly those in which the various component parts are manufactured for " New World " cookers. These included the press department, where pressings and stampings are made, the brass turning department, adjoining which is a section mainly devoted to the assembling and testing of the " Regulo " oven heat controllers, machine shops, drilling shops, and fitting departments, where attention was drawn to the careful way in which all component parts are " jigged " to ensure perfect fitting. Much interest was created, of course, in the making of the castings from the moulding of the iron in the cupola. The enamelling department, together with the sand blasting section, was the subject of particular attention, and here were shown the various types of enamelled castings and sheet iron linings, &c., which are constantly in process. In addition to the manufacturing and assembling of " New World " cookers there was to be seen the making and assembling of gas fires, hotplates, and many other appliances in which the Firm specializes. Another branch of the Firm's business which attracted considerable attention was the bath making and bath enamelling department, this taking up a considerable area of the Works; the methods of enamelling baths have always been an unfailing source of interest to visitors.

After the tour of the Works the party were entertained at tea. The Chairman of the Council, Mrs. N. Cunningham, proposed a vote of thanks to Messrs. Wilsons & Mathiesons, Ltd., being seconded by Mrs. F. Sunderland, to which Mr. W. Mathieson, Managing Director, responded, thanking them for the very great interest which they had shown in the visit.

Kitchen Fashions and Food Shows

Sheffield's Ambitious Programme

An ambitious programme of cookery and washing demonstrations and films has been arranged by the Sheffield Gas Company and is being presented as from to-day for three days at the New Arcadian Hall, Barnsley. There will be two sessions daily—viz., at 2.15 p.m. and 6.15 p.m., and before the demonstrations begin the consumers will have an opportunity of inspecting various appliances displayed and seeing a film show. The Company's demonstrators, Miss Gertrude Whitaker and Miss Dorothy Dickenson, have spent weeks planning a programme that will really entertain and interest the consumer.

On the first day the afternoon session is devoted to " Pocket Book Menus " and a washing machine demonstration, which is a feature of all the subsequent sessions. In the evening " The Bride Walks Out " and leaves Mr. Therm to do the cooking. On Thursday afternoon there will be a demonstration of " cold cookery," while the evening session will be of especial interest as it will feature foreign recipes. On the final day " Yorkshire Hospitality " and " Hollywood Parade " (Food of the Film Stars) will be the subject of the two sessions. Each evening in addition a complete dinner will be cooked without attention in a gas oven.

Before and after the cookery lectures there will be special shows of the B.C.G.A. films. Music will be played and audiences can view exhibits along each side of the hall which include: A model kitchen and an old kitchen; display of modern kitchen equipment; display of various foods (classified according to dietetic practice); display of newest kitchen fashions—house frocks, overalls, curtains, tablecloths, &c.; a special " cold cookery " display—refrigeration, &c. The cookery lectures are conducted by Margaret Noble, Cordon Bleu, M.C.A., and Gertrude Whitaker (Chef-de-Cuisine). The washing machine demonstrations are in the expert hands of Dorothy Dickenson. The whole of this Kitchen Fashions and Food Show has been planned and prepared by the Home Service Bureau of the Sheffield Gas Company.

A Coronation Window Display

This special Coronation Window Display was expressly produced by the Parkinson Stove Company, Ltd., for a large number of gas undertakings throughout the country. It was effectively executed in full Royal colours and gold, and, as can be seen, features the firm's well-known " Renown " gas cooker.

Further News and Views

of the Industry's Part

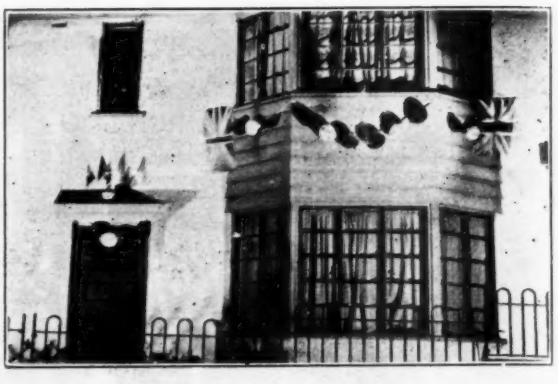
In the Recent Coronation Festivities

Above we see how the Wolverhampton Gas Company decorated their chief Showrooms during Coronation Week with coloured streamers and appropriate window displays; and on the right is the entry of the Ludlow Union Gas Company which was awarded the First Prize in the local Coronation Carnival Procession.

Two small boys were admiring the decorations; but one was rather intrigued by the meaning of the letters G. & E. which had a place of honour on either side of the illuminated crown.

"What do they stand for?" he asked.

"Don't you know?" replied the other, shocked by such abysmal ignorance. "Why, they mean the gas and electricity wot supplies the light!"



The Gas Manager at Brecon effectively Floodlighted his House with Gas for the Occasion.

The photograph on the left shows the excellent results obtained by floodlighting the Manchester Police Headquarters with gas, while below we have an interesting comparison between two Manchester gas signs—for the Jubilee of Queen Victoria and for the Coronation of her great grandson, King George VI.

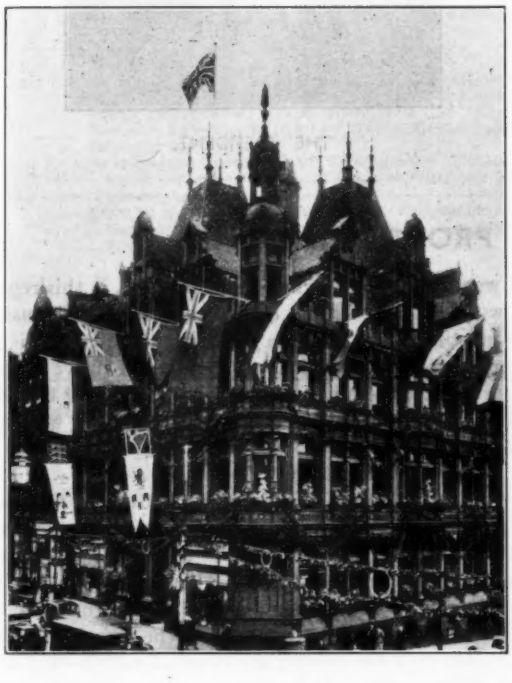
The Queen's Former Home Floodlighted by Calor Gas

Glamis Castle, ancestral Scottish home of the Earls of Strathmore, was beautifully floodlighted by Calor gas.

A copy of this photograph was sent to H.M. the Queen by Calor Gas (Distributing) Company, Ltd., and the following reply was received:

BUCKINGHAM PALACE,
19.5.37.

The Lady-in-Waiting to The Queen is commanded to express Her Majest 's sincere thanks to The Directors and Staff of Calor Gas for the kind expressions conveyed in their communication of the 14th inst. and the photograph enclosed.



Left.—The Chief Office of the Newcastle-upon-Tyne and Gateshead Gas Company gaily decorated during the Coronation Festivities.

Above.—An original tableau prepared by the Luton Gas Company or the local Carnival Procession, where it created considerable interest.

Topical Window Display from Coventry

An interesting link-up with the Coronation was provided by this original display arranged by the City of Coventry Gas Department in their Central Showroom window. Mr. P. N. Langford reports an 86% increase in domestic appliance sales last month as compared with April, 1936

Annual Meeting of
THE INSTITUTION OF GAS ENGINEERS

JUNE 1 to 4,

1937

The Business Sessions of the 74th Annual General Meeting of The Institution of Gas Engineers will be held in the Hall of the Royal Geographical Society, Exhibition Road, Kensington, S.W. 7, under the Presidency of Mr. Stephen Lacey. The programme of the meeting will be found on the following page.

THE PRESIDENT.

A WELL-BALANCED PROGRAMME

NEXT week, under the Presidency of Mr. Stephen Lacey, there will be held in London the 74th Annual Meeting of The Institution of Gas Engineers, the meeting place being new—the Royal Geographical Society in Exhibition Road. In this Special Number of the "JOURNAL" we give abstracts of the Papers to be presented; and it will be generally agreed that the selection of the Papers has been admirable.

We confidently anticipate lively discussions, for the subjects to be dealt with are so very much to the fore in the minds of those who will take part in the meeting. The programme is exceedingly well balanced, and the various communications link up to the one aim of giving the consumer the best gas service at a cost as low as possible. The Papers illustrate, too, the clearer view which the Gas Industry has developed during the past year or so as to the channels into which its energies should be directed to bring about the maximum rate of progress. The activities of the Industry have, in fact, become less diffuse, and its outlook is less conservative. The recruitment of a large number of keen and capable young men into the Industry's ranks has undoubtedly been a primary factor influencing this change.

Manufacture, distribution, the future of gas appliance design, consumer service—all these topics are to come up for discussion; and those who have grievances against the holding company movement will have the opportunity of airing their views on Wednesday morning. A central theme of the meeting will, we think, be to what extent it is desirable to modify the practice of gas manufacture to produce a supply of gas having the right characteristics to render its use in modern gas appliances, and in appliances likely to be developed in the future, at all times satisfactory. Fortunately it has been recognized that we are hazy as to what we really want in this regard, and work is proceeding to clarify the issue. The Institution meeting will provide a platform to discuss this all-important problem, which, we hope, will prove a focus of attention. We hope, too, that as a result of the communications to be submitted gas undertakings will more generally apply processes which have been shown to result in a better gas service.

By no means the least important feature of the meeting next week is submission to corporate members of Resolutions for the amendment of the by-laws governing admittance to the Institution. This matter of membership has, over a long period now, given rise to much controversy; and it is to be hoped that the new Resolutions will result in a far greater measure of satisfaction than exists to-day with the by-laws, which debar so many technical workers whose help is of the utmost importance to the progress and prosperity of our Industry. Then, as for the visits, these should prove extremely interesting, and the organizing ability of Mr. Alexander, whose last meeting it will be as Secretary of the Institution, is, as on former occasions, certain to ensure all possible comfort for those participating. Arrangements have been made for visits to the Fulham Gas-Works of the Gas Light and Coke Company and to the Gas Manufacture Research Laboratories, the new Watson House, and the Stove and Meter Works. Other visits include one to the National Maritime Museum at Greenwich and one to the Royal Zoological Gardens in Regent's Park. Friday, the final day of the meeting, is to be devoted to a tour around Folkestone, and those taking part will be entertained at luncheon by the Folkestone Gas and Coke Company. As last year, the Reception will be held at Grosvenor House, which has the largest ballroom floor in London.

PROGRAMME OF THE MEETING

TUESDAY, JUNE 1.

10. 0 a.m. Opening of the 74th Annual General Meeting. Welcome to Representatives from Overseas.
Adoption of the 74th Annual Report and Accounts (*Communication No.* 151). Scrutineers' Reports of the Ballots. Presentation of Medals.
Presidential Address by Stephen Lacey, B.Sc., M.Inst.C.E., Controller of Gas Sales, the Gas Light and Coke Company. (*Communication No.* 152).

11. 0 a.m. Paper on "The Consolidation of Gas," by C. F. Broadhead, M.Inst.Gas E., Engineer, The Metropolitan Gas Company, Melbourne, Australia. (*Communication No.* 153).

12.15 p.m. Photograph of the Meeting.

12.45 p.m. President's Luncheon, Savoy Hotel, Victoria Embankment.

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3. 0 p.m. Paper on "The Estimation of Nitric Oxide in Gas," by H. Hollings, M.Sc., Chief Gas Chemist, the Gas Light and Coke Company. (*Communication No* 154).

3. 5 p.m. Paper on "Changing Influences in Gas Manufacture," by E. G. Stewart, Assistant Chief Engineer, the Gas Light and Coke Company. (*Communication No.* 155).

4. 5 p.m. Submission to Corporate Members of Resolutions for the Amendment of the By-Laws Governing Admittance to the Institution and of other By-Laws.

9. 0 p.m. Reception and Dance, Grosvenor House, Park Lane, W. 1,

WEDNESDAY, JUNE 2.

10. 0 a.m. Paper on "Distribution of Gas in Suburban and Rural Areas," by H. J. Escreet, B.Sc.Eng., Distributing Engineer, the Gas Light and Coke Company. (*Communication No.* 156).

11. 0 a.m. General Meeting of The Benevolent Fund.

11.15 a.m. Paper on "Technical Aspects of the Holding Company Movement," by G. M. Gill, M.I.Mech.E., Director, Severn Valley Gas Corporation, Ltd , and Gas Consolidation, Ltd. (*Communication No.* 157).

2.15 p.m. to
6. 0 p.m. Visits by Motor Coach to the Gas Light and Coke Company at Fulham :—(1) Gas Works ; (2) Gas Manufacture Research Laboratories ; (3) Gas Distribution and Utilization Research Laboratories (the new Watson House) ; and (4) Stove and Meter Works.
Visit to Science Museum (South Kensington).* Tickets will not be necessary. Members will make their own transport arrangements.
Visit by Motor Coach to and Tea at National Maritime Museum (Greenwich), opened by H.M. the King on April 27, 1937.*

THURSDAY, JUNE 3.

10. 0 a.m. Paper on "The Future of Gas Appliance Design," by C. A. Masterman, M.A., M.I.Mech.E., F.I.C., Chief Technical Officer, Watson House, the Gas Light and Coke Company. (*Communication No.* 158).

11. 0 a.m. Paper on "Consumer Service," by R. N. Le Fevre, A.I.Mech.E., Officer in Charge of Training, Watson House, the Gas Light and Coke Company. (*Communication No.* 159).

12 noon to
12.15 p.m. Concluding Business of Meeting.

12.45 p.m. Council Luncheon to the President at 1, Grosvenor Place, S.W. 1.

2.15 p.m. to
6. 0 p.m. Visits by Motor Coach to the Gas Light and Coke Company at Fulham (see previous afternoon).
Ladies' Visit by Motor Coach to and Tea at the Gardens of the Royal Zoological Society (Regent's Park).

FRIDAY, JUNE 4.

VISIT TO FOLKESTONE.*

Charing Cross—Shorncliffe—Folkestone—Lympne—Sandling.

Morning : Charing Cross (9.30 a.m.) by Special Train to Shorncliffe Station.
Drive by Motor Coach in and around Folkestone and Visit to Gas Showrooms.
Luncheon by invitation of the Folkestone Gas and Coke Company at the Hotel Metropole, Folkestone.

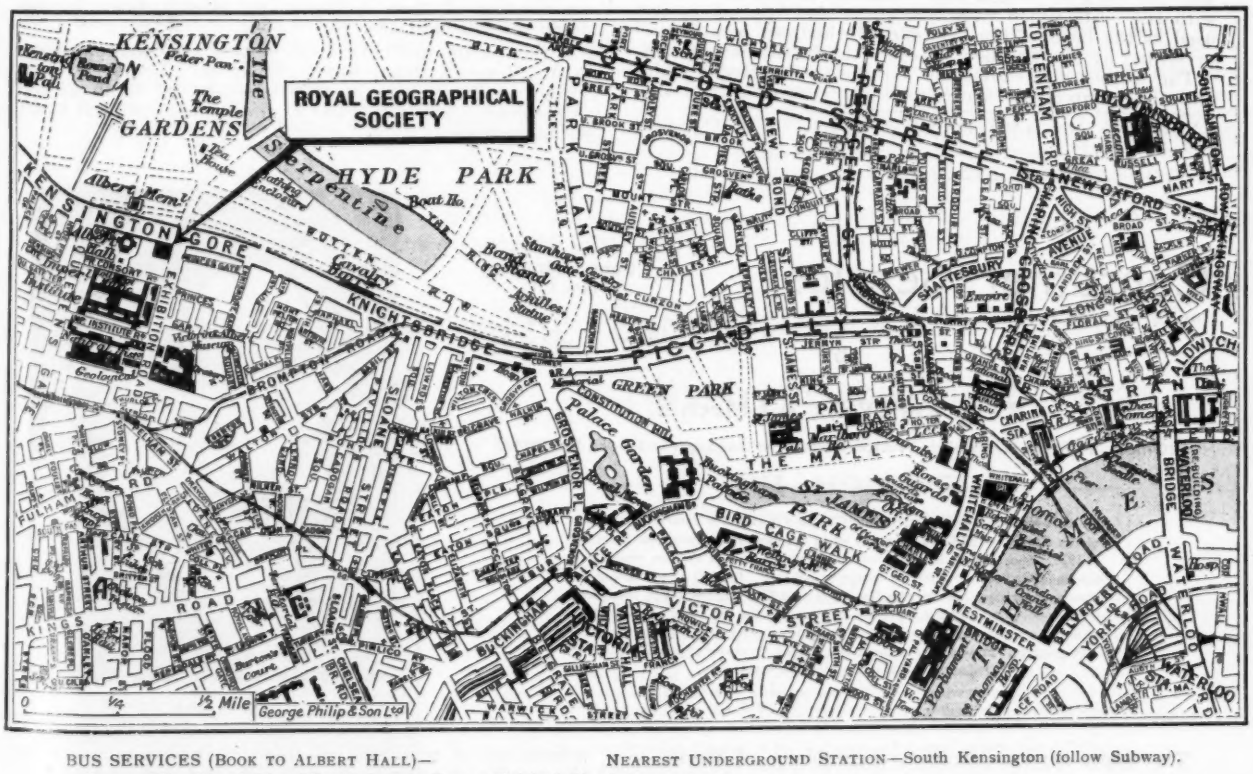
Afternoon : Visit by Motor Coach to (i.) Royal Air Force Station and Cinque Ports Flying Club at Lympne Aerodrome, (ii.) Gardens of Port Lympne (Residence of Sir Philip Sassoon), and (iii.) Lympne Castle (Tea).

Evening : Lympne Castle by Motor Coach to Sandling.
Sandling Junction Station by Special Train (on which Supper will be served) to Charing Cross Station (8.30 p.m.).

The arrangements permit of the issue of Tickets omitting the Special Train journey and/or the Drives and Visits. The Railway Ticket will entitle the holder to travel on the Special Train or on any Ordinary Train to and from Folkestone on the Friday. The Ticket may be converted to a Summer Return Ticket on payment of a supplement at Folkestone Station.

* Ladies may participate.

HOW TO REACH THE MEETING



BUS SERVICES (BOOK TO ALBERT HALL)—

No. 9—City, Strand, Piccadilly, Hyde Park Corner, Knightsbridge (every 3 mins.).
No. 33—Aldwych, Piccadilly, Hyde Park Corner, Knightsbridge (every 5 mins.).
No. 46—Victoria, Pimlico Road, Sloane Street (every 10 mins).
No. 52—Victoria, Grosvenor Place, Hyde Park Corner, Knightsbridge (every 2½ mins.).
No. 73—Tottenham Court Road, Oxford Street, Marble Arch, Park Lane, Hyde Park Corner, Knightsbridge (every 2 mins.).

NEAREST UNDERGROUND STATION—South Kensington (follow Subway).

THE INSTITUTION AUTHORS

WITH **Summaries of their Technical Communications**

Distribution of Gas in Suburban and Rural Areas

Communication No. 156

Mr. H. J. ESCREET.

by

H. J. ESCREET, B.Sc.Eng.

(Distributing Engineer to the Gas Light and Coke Company)

Educated at the City of London School, Mr. Escreet entered the Gas Light and Coke Company in 1912 as a clerk. In 1914 he commenced his training as Staff Pupil at Beckton. From 1915 to 1918 he served in the Royal Field Artillery, returning to Beckton on the cessation of hostilities. In 1920 he was transferred to the Distribution Department on the completion of his pupilage, being appointed Assistant Distribution Engineer in 1923, the same year that he obtained the degree of B.Sc. (Engineering) as an external student of the University of London. In 1933, he was appointed Distribution Engineer in succession to Mr. Stephen Lacey. Mr. Escreet is also an Associate Member of the Institution of Civil Engineers.

In this Paper examples are given of the cost of distribution in the area of the Gas Light and Coke Company, and the costs of mainlaying, pumping, &c., are compared with the costs which were quoted in the Appendices and used as the basis of the examples worked out in a Paper* presented by Mr. Stephen Lacey to the Institution in 1928.

The Author also shows how far the size of feeder mains and the pumping pressures used are consistent with the principles laid down in that Paper, which dealt with the relation between initial pressure, size of main and volume of gas to be supplied, and showed how the most economical combination of these factors might be calculated for any given set of conditions.

Although the methods of calculation and examples given in Mr. Lacey's Paper apply chiefly to schemes for bulk supply or long distance transmission, the same general principles are applicable to the development of local feeder mains systems.

* "Economic Aspects of High-Pressure Distribution." Trans.Inst.Gas Eng., 1927–28, 250.

Consumer Service

Communication No. 159

Mr. R. N. LeFEVRE.

by

R. N. LeFEVRE, A.I.Mech.E.

(Officer in Charge of Training, Watson House, the Gas Light and Coke Company)

Mr. LeFevre joined the Brentford Gas Company in 1920 and entered the service of the Gas Light and Coke Company when the former Company was absorbed in 1926. Shortly after its inception he joined the staff of Watson House, and subsequently became Officer in Charge of Training. In 1930 he was appointed part-time Assistant Head of the Department of Gas Engineering of the Westminster Technical Institute. He is well known as the co-author of "Domestic Utilization of Gas" and the author of many other works and articles on utilization practice. Mr. LeFevre is the newly elected President of the London and Southern District Junior Gas Association.

The Paper reviews the general problems of service to the gas consumer and describes the varying degrees of service which may be given by Gas Undertakings.

A description of the consumer service policy of the Gas Light and Coke Company includes the fundamental considerations of good service—the design of appliances and the quality of equipment, material, and men.

The Paper outlines for discussion certain recommendations for co-operation throughout the Gas Industry with regard to the training of personnel, a matter without which no satisfactory service policy can be attempted.

The Consolidation of Gas

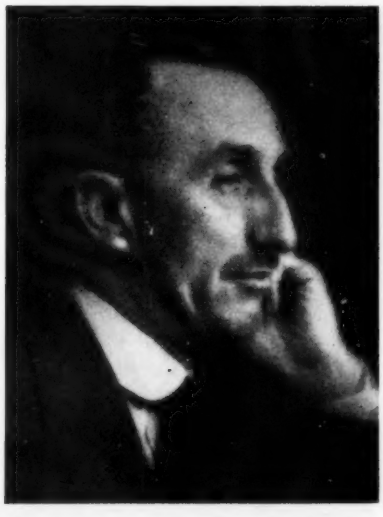
Communication No 153

by

C. F. BROADHEAD

(Engineer, Metropolitan Gas Company of Melbourne, Australia)

Mr. Broadhead is an example of the third generation connected with the Gas Industry. Following in the footsteps of his grandfather, Matthew Broadhead, and his father, James Broadhead, Mr. C. F. Broadhead commenced his career at the Grimsby Gas-Works under his father, who was then Engineer there. After spending some years at Grimsby he went to Nottingham, where he spent some time under the then Chief Engineer, Mr. Brown. His first independent appointment was that of Engineer of the Middleton Corporation Works, in Lancashire. In 1912 he secured an appointment as Chief Engineer of the Brisbane Gas Company. After thirteen years at Brisbane, during which time big improvements were effected to the plant and equipment, he was, in 1925, appointed Assistant Engineer to the Metropolitan Gas Company of Melbourne, whose Engineer at that time was Mr. Reeson. Upon the latter's retirement, Mr. Broadhead succeeded him and still occupies that important position. It is noteworthy that the Metropolitan Gas Company has had a succession of Engineers, all of whom received their training in this country—namely, Mr. P. C. Holmes Hunt, Mr. Reeson, and now Mr. Broadhead.



Mr. C. F. BROADHEAD.

The Paper may be regarded as a record of ten years' development within the area of supply of the Metropolitan Gas Company, Melbourne, where gas, coke and tar are in exceedingly keen competition with electricity, brown coal briquettes and bitumen, the predominant feature being the importance of gas as our main product in contradistinction to the decreasing value of residuals in a progressive age.

The Author considers the future of the Gas Industry as dependent eventually upon the production of cheap gas. With the trend of the times in the direction of automatically controlled fluid fuel it would appear that unless the heat unit content of coal is of greater value in the form of gas than it is in the form of coke our future business is being built up on a somewhat insecure foundation. For this reason, the coal consumption in Melbourne during the past decade has been reduced by approximately 75,000 tons per annum with a consequent decrease in the production of residuals.

A new coal handling plant has been installed, resulting in much greater expedition in unloading coal boats and a considerable saving in cost.

All horizontal and inclined retorts have been scrapped and a carburetted water gas plant substituted.

Approximately 50,000 tons of coke per annum have been taken off the local market, the sale by the State Electricity Commission of brown coal briquettes having increased enormously during the past ten years.

The sale of tar to Municipalities and tar distillers for road making purposes has decreased by 3,000,000 gallons per annum during the same period, due to intense competition from bitumen. The position in relation to road making in Australia is discussed.

The situation in Melbourne has led to serious consideration of the complete gasification of fuel and a section of the Paper is devoted to a résumé of research work carried out on the subject during the past two years. The design of the plant has been determined to a large extent by the desire that it should be capable of dealing with all classes and combinations of solid and liquid fuels, more especially brown coal and vertical retort tar. The tests enumerated were specially carried out for inclusion in this Paper, and constitute a fraction only of the total work done on the subject. The installation of automatic control greatly facilitated the successful working of the pilot plant.

A section on condensation, washing and dehydration expresses the view that this branch has not received the attention it deserves and suggests that an extension of the intense cooling system installed at South Melbourne would effect the removal of impurities to a degree in which they become innocuous. Purification proper would thereby be simplified and could be carried out even more economically and effectively by the oxide of iron method.

Special mention is made of distribution improvements, including a detailed account of the new Preston outstation which is automatically controlled throughout.

The Company has its own Construction Department and Meter Works.

The final portion of the Paper is devoted to a summary briefly covering the commercial side.

Mr. H. HOLLINGS.

The Estimation of Nitric Oxide in Gas

Communication No. 154

by

H HOLLINGS

Chief Gas Chemist, Gas Light and Coke Company)

Mr. H. Hollings entered the University of Leeds in 1909. After graduating n 1912 he held the Gas Research Fellowship of The Institution of Gas Engineers for two years, during which period he carried out researches upon the carbonization of coal and the decomposition of hydrocarbons. In 1914 he proceeded to the Degree of M.Sc. and was awarded the Leblanc Medal for special distinction in Gas Engineering, subsequently joining the staff of the South Metropolitan Gas Company where he was engaged upon the manufacture of products required by the Ministry of Munitions. Later he became Senior Gas Chemist to the Company. In 1924 Mr. Hollings was appointed to his present position as Chief Gas Chemist to the Gas Light and Coke Company. In 1930 he was awarded the Moulton Medal of the Institution of Chemical Engineers. He is a member of the Research Executive Committee of the I.G.E., the Council of the British Refractories Research Association, and the Technical Committee of the L.C.C.A.

Technical Aspects of the Holding Company Movement

Communication No. 157

Mr. G. M. GILL.

by

G. M. GILL

(Director, Severn Valley Gas Corporation, Ltd., and Gas Consolidation, Ltd.)

Educated at Lancing College Mr. Gill became a pupil of the late H. E. Jones, Past President of the Institution of Civil Engineers and The Institution of Gas Engineers. After his pupilage he was for a period of 12 years in the service of the Commercial Gas Company in London, and held successively appointments of Assistant Engineer of the Poplar Gas-Works, Engineer and Manager of the Wapping Works, and Assistant Engineer to the Company. In December, 1915, he was appointed Chief Engineer to the South Metropolitan Gas Company which position he held until July, 1922, when he started practising as a Consulting Engineer in Westminster. In this capacity he developed a considerable practice in foreign countries, particularly during the period 1924-1931, when he travelled very extensively in many countries, including seven visits to the U.S.A. on work connected with the manufacture and distribution of gas. From 1932 to the present date he has been actively associated with the South Eastern Gas Corporation, Severn Valley Gas Corporation, and Gas Consolidation, Ltd.

In this Paper, the Author discusses the methods and policy adopted by two Holding Companies with which he is intimately connected, together controlling 36 subsidiary Companies with an aggregate make of over 4,000 million cu.ft. of gas per annum.

The financial advantages of the system to the associated Companies are considered, including the resulting possibility of extension and modernization of manufacturing plant and distribution mains.

The duties of the Directors and special secretarial, financial, sales and technical Staff are outlined, and their co-operation in the work of the subsidiary Companies is described.

Such Staff enables most of the problems with which the group of Companies is confronted to receive prompt and expert attention and to be solved with success and at relatively small expense.

The Future of Gas Appliance Design

Communication No. 158

Mr. C. A. MASTERMAN.

by

C. A. MASTERMAN

(Chief Technical Officer, Gas Light and Coke Company)

Mr. Masterman was educated at Gresham's School, and gained a Natural Science Exhibition, Balliol College, Oxford, in 1914. After the war he resumed his studies at Balliol College, reading chemistry. Having taking the Degree of B.A., he remained at Oxford on research work for the War Office, and was later appointed Senior Assistant in the Defensive Munitions Department at the Experimental Station at Porton. Mr. Masterman joined the Gas Light and Coke Company in 1927, becoming Senior Chemist, and later Chief Technical Officer in charge of the laboratories and other activities at Watson House.

Expansion in the use of gas comparable with the opportunities which lie ahead can be realized only by whole-hearted co-operation between the Gas Undertakings and the appliance Manufacturers. The last ten years have shown directions in which advance in design is to be expected.

Average present annual requirements of heat for domestic purposes per household are derived as about 270 useful therms (requiring 540 therms of gas), of which gas and coke now supply nearly 40 per cent. in about equal proportion. These two fuels can offer a combined smokeless fuel service normally at a cost no higher than raw coal, a condition fulfilled by gas alone with all its attendant advantages if its increased use and the operation of special tariffs can reduce its average price by about 30 per cent. For domestic heating purposes average-price current is non-competitive with gas on cost, while the amount of off-peak current available will always represent only a small proportion of domestic heat requirements. The displacement of coal in the home by gas and coke requires more than doubling the output of the Gas Industry, without allowing for increased demand for heat in home and factory, which must accompany improved standards of living and progress in industrial prosperity.

Burners will be further developed, especially in flexibility. Appliances will benefit from the introduction of

new materials in construction and fresh ideas in appearance. Water heating and space heating by gas will each develop into loads greater than the cooking load.

Water heating appliances of the circulator type will displace or reinforce the coke boiler. Single-point heaters at sink and bath or small multipoint heaters will economically serve the needs of the poor, while gas installations will provide completely automatic and abundant hot water service for the well-to-do. Appliances for the home laundry will be further developed.

Gas fires of improved design will serve the double purpose of heating and ventilating, but increasing appreciation of the science of comfort will lead to the development of modified or new space heating appliances. Small units for heating the air in occupied rooms as well as in halls and passages will be more generally used, often under thermostatic control.

Appliances for the large-scale uses of gas will in many directions reflect the improvements in domestic gas appliance design and technique. Industrial appliances of other characteristics will with increasing accuracy ensure throughout the working space the required conditions of temperature and atmosphere to enable a maximum throughput of standard quality to be maintained, a requirement further assisted by the increased use of automatic feed and conveyor.

An Appendix summarizes the evidence from which the comparative efficiencies of the various fuels are derived.

Changing Influences in Gas Manufacture

Communication No. 155

Mr. E. G. STEWART.

by

E. G. STEWART

(Assistant Chief Engineer, Gas Light and Coke Company)

Receiving his technical education in Civil, Mechanical, and Electrical Engineering at the Portsmouth Technical College and later at the Northampton College, London, Mr. E. G. Stewart entered the Gas Industry in 1906, serving three years in the shops and drawing office of the Portsmouth Gas Company, under Mr. J. D. Ashworth. In 1909 he became Engineer Staff Pupil of the Gas Light and Coke Company, being appointed a Junior Assistant Engineer in 1912. In 1917 he was appointed Senior Assistant Engineer. In 1922 he became Station Engineer at Ilford, and on the closing-down of those works he was appointed Assistant to Mr. Thomas Hardie, then Chief Engineer of the Company. In January, 1936, Mr. Stewart was appointed Assistant Chief Engineer of the Gas Light and Coke Company.

Changes in the business conditions of the Gas Industry and its technical progress since the passage of the Gas Regulation Act of 1920 are reviewed, and it is concluded that the intentions of Parliament in passing this Act have been realized, in that the cost of gas making has been reduced, statutory requirements have been met, the efficiency of gas manufacture has risen and the sale of gas has been extended with increased consumer satisfaction.

Consideration is given to a number of refinements which have been introduced to give better consumer service in recent years, including the removal of naphthalene, water vapour and sulphur from the gas. Certain difficulties which arose from the introduction of these processes are mentioned, and it is suggested that the difficulties, for which solutions have been found, may have contributed to the somewhat limited adoption of these desirable processes.

The calorific values which have been declared throughout the country are examined and it is seen that 844 Gas Undertakings have selected 28 different calorific values. Analysis shows that over 90 per cent. of the gas sold in this country is of a calorific value between 450 and 500 B.Th.U., and the proposal is made that 5 or even fewer values could be standardized with advantage to the manufacturer of gas appliances.

The variations in the properties of gas which affect the operation of the burner in gas appliances are set out, and reference is made to recent work in Germany, Switzerland, the U.S.A., and this country directed towards the establishment of means of assessing desirable properties in gas to secure the maximum value in use. Calorific value and specific gravity can be measured and controlled with precision. The shape of the flame produced is of considerable importance in order to avoid incomplete combustion, popping back, noisy operation, &c. This cannot be calculated, and instruments for the empirical assessment of desirable characteristics in gas to produce such flames have been devised.

To-day those responsible for the development of gas-using appliances are considered to be within measurable distance of gaining ability to specify characteristics in gas which will yield to the gas user proper and highly efficient service. Unfortunately, insufficient work has as yet been done to correlate these tests with the precise composition of individual acceptable gases.

In the absence of this information the gas manufacturer can only meet the higher standards of gas quality demanded to-day by limiting the flexibility of his operations, and by avoiding large changes in the use of water gas and diluent gases. Limits so imposed need not be very onerous if a stable and remunerative coke market can be established, and the present conditions in coke marketing are examined. The view is held that the outlook for coke presages a growing and remunerative market, which can with care and planning be kept free from the fluctuations of past years.

At the same time it is difficult to make gas of a quality with narrow limits of variation and at the same time meet seasonal peaks due to cold weather or other causes. It is shown that hand operated water gas plant is the most economical means at present available for meeting these peaks, but it is probable that some method of balancing the variations in quality due to its use may have to be sought. The use of small mains at high pressures to link up adjacent Gas Undertakings so as to spread peak demands is suggested.

Reference is made to complete gasification, and the value of the process employing oxygen and high pressure in making gas similar in characteristics to that from present processes is indicated.

It is concluded that the business of gas making is likely to become more complex in future, and that the closest collaboration between engineer, chemist and other trained scientific workers will become more and more essential.

The necessity is stressed for the manufacturing side of the Gas Industry viewing critically such gas using appliances as may require undue limitation of gas quality, and certain lines of research of value to it are indicated as desirable. Meanwhile, it is suggested that not only should efforts be made to limit changes in gas composition, but that the benefits of dehydration, denaphthalenation and reduction of sulphur compounds should be extended as widely and as soon as possible.

The "JOURNAL" Abstracts of the Communications

A full report of the discussions on the Papers will appear, as usual, in our Second Institution Number on June 9

In the following pages are abstracted the Papers to be presented at the 74th Annual General Meeting of The Institution of Gas Engineers next week under the Presidency of Mr. STEPHEN LACEY, Controller of Gas Sales to the Gas Light and Coke Company.

The Consolidation of Gas

Communication No. 153

by
C. F. BROADHEAD
(Engineer, Metropolitan Gas Company of Melbourne, Australia)

COAL, COKE, AND TAR.

COAL.

Naturally, the first step in any consolidation scheme would be to reduce the quantity of coal carbonized and consequently of residuals produced and concentrate on an increased production of gas.

The coal used by the Company in normal times is drawn from the Maitland field in New South Wales, and is shipped from Newcastle to Melbourne, a distance of over 600 miles. In 1926 the amount of coal carbonized by the Company was 342,514 tons which produced 4,711,828,000 cu.ft. of gas, or 77 therms per ton. During 1936 267,170 tons of coal were carbonized producing 4,751,272,000 cu.ft., or 91 therms per ton (oil therms deducted), a reduction of 75,344 tons of coal per annum and an increased thermal yield of 18 per cent.

First-class Maitland coal, an analysis of which appears in the complete gasification section, is a somewhat embarrassingly rich coal producing normally about 80 therms of high calorific gas (over 600 B.Th.U. per cu.ft.) which may be increased to 100 therms of 500 B.Th.U. gas by steaming in suitable vertical retorts. In steaming a disadvantage when carbonizing Maitland coal alone is its tendency to shrink away from the walls of the retorts, more especially with intermittent charges.

COKE.

Maitland coal, considering its rich gas content, produces an excellent coke, as will be noted upon reference to the analyses of materials used in complete gasification. Prior to the introduction of brown coal briquettes, manufactured by the State Electricity Commission at Yallourn, 90 miles from Melbourne, little difficulty was experienced in disposing of the entire production. As we were certain, ten years ago, to lose our largest coke customer—the Tramways Board—who purchased 30,586 tons in 1926, owing to the conversion of the cable trams to electrical power, and it appeared probable that the coke sales in Victoria would be adversely affected by brown coal briquette and oil fuel competition, it was decided to install a carburetted water gas plant, which since 1929 has had the effect of taking approximately 385,000 tons of coke off the market. This action, in conjunction with the high figure of 32s. 9d. per ton charged to the water gas plant, has resulted in maintaining the price of coke at a relatively uniform level.

The sale of coke and breeze by the Metropolitan Gas Company compared with that of briquettes by the State Electricity Commission during 1926 and 1936 respectively was as follows:—

	1926.		1936.
Coke and breeze . .	181,369 tons	..	130,195 tons
Briquettes	85,781 ,,	..	336,487 ,,

Unfortunately, no dissection is available of the various classes of purchasers of coke and breeze prior to the year 1931, but Table 1 shows the dissected sales since that date.

TABLE 1.—*Dissected Sales of Coke and Breeze.*

—	1931.	1932.	1933.	1934.	1935.	1936.
1	2	3	4	5	6	7
Industrial and commercial . . .	67,639	64,317	65,757	66,930	76,713	79,347
Domestic . . .	21,301	23,907	22,598	25,315	29,175	31,177
Water gas manufacture . . .	16,292	17,634	17,255	18,023	19,099	19,671
Total . .	105,232	105,858	105,610	110,268	124,987	130,195

In connection with this Table, it is interesting to note, that the bulk of our lowest priced solid fuel—breeze—is consumed by the City Power Station for the generation of electricity. Unless due consideration is given to the local conditions prevailing in Victoria, an erroneous interpretation might be placed upon the above figures. It would appear that as the coke sales are again on the increase, the residuals policy enunciated in this Paper may be unwarranted. In competition, however, with coal from State controlled mines and briquettes from almost inexhaustible brown coal deposits, there exists a very narrow margin between saturation point of the coke market on the one hand and the present rate of coke production on the other, as evidenced by an accumulated stock of 5,000 tons of coke at the end of last winter.

The residuals salesmen have been untiring in their efforts and there is no doubt that the present position has been brought about by the demand for a more convenient fuel, for which the public is prepared to pay an enhanced price.

In the future the private household demand must be for a clean and convenient fuel. Coke, as usually sold, is neither clean nor convenient, and if it paid its proper share of the carbonizing process cost it would not even be cheap.

It is the Author's opinion that the cultivation of the domestic coke field should be abandoned, with the possible exception of blocks of flats—if the term domestic is applicable to this form of existence—where a man has to be employed in any case and can attend to the coke installation in addition to other duties.

These circumstances, allied to the fact that the industrial and domestic gas load in Melbourne is capable of very considerable development, which would result in greater gas consumption with a corresponding increase in coke and tar production, lead one to the realization that the products of the Gas Industry cannot be kept in balance without having available a satisfactory means of producing gas from either coal or surplus coke and tar.

TAR.

It would be impossible to over-emphasize the absolute debacle which has occurred in the tar market in Victoria during the past decade.

The quantity of tar produced by the Metropolitan Gas Company in 1926 amounted to 5,409,755 gal., compared with 5,106,672 gal. in 1936. The production per ton of coal carbonized in 1936 was 20 gal. in the Continuous Vertical Plant and 12 gal. in the Intermittent Verticals.

The disposal of this product was as follows:

	1926.		1936.
Sold to Municipalities	2,873,098 gal.	..	382,517 gal.
,, ,, tar distillers	1,407,372 ,,	..	819,788 ,,
,, ,, Country Roads Board	..	..	451,766 ,,
,, for fuel	..	..	1,059,771 ,,
,, miscellaneous	459,064 ,,	..	50,230 ,,
Used in water gas plant	..	..	340,710 ,,
,, on works as fuel	..	..	1,786,270 ,,
Total	4,739,534 gal.	..	4,891,052 gal.

In contradistinction, the importations of bitumen into Victoria are shown hereunder:—

	1926.		1936.
Gallons	3,168,220	..	7,325,340
Price per ton	£6 12s. 6d.	..	£4 1s. 9d.

The decrease in revenue from tar to the Metropolitan Gas Company in the ten years is estimated at a total of £450,000.

There can be no question that this enormous loss has been caused by the unsuitability of tar produced from Maitland coal in continuous vertical retorts for modern methods of road construction and the dumping of a rival by-product—bitumen.

Conditions in Australia differ considerably from those existing in most other countries. In the formation of roads of rigid construction to carry heavy traffic, as is the case in Great Britain and European countries, distilled tar has been proved to be suitable, at least for penetration if not for the final seal coat. In Australia, however, where there is a growing need for extensive roadway construction through the sparsely populated regions of the country, such expensive methods are not justifiable. On the other hand, earth or gravel roads demand high maintenance costs, so Authorities have devoted their attention to the development of cheap, light traffic roads. These consist of non-rigid earth or gravel roads primed with a priming tar (6 to 12 Engler viscosity) on the surface of which is built up a flexible bituminous mat. Any movement in these roads must be taken up by the flexibility of the surface binder, even several years after application. Tars, under these conditions, are liable to crack, permitting the entrance of water, which would result in the disintegration of the road. With this type of road construction one can afford to use only the best material available.

Strenuous efforts have been made by the Metropolitan Gas Company to meet this position, and a specially prepared tar, known as Bitural, was produced as the result of considerable research. This was the only prepared tar that the Victorian Country Roads Board considered in the selection of binders for their road construction programmes, and 10,000 tons of this product were used, mainly as a first seal coat in the particular type of construction just described. With the price of bitumen, however, at £4 1s. 9d. per ton, it was impossible to compete, and Bitural has been replaced, to a large extent, by bitumen fluxed with light dehydrated tar.

Owing to the opposition of Municipal and Shire Councils in Australia, it has been impossible to move the Tariff Board to recommend protection. The attitude adopted is an exception to the rule in Australia, and has been a very costly one as far as the Gas Companies are concerned. These Municipalities, whose knowledge of modern road construction methods is limited, prefer bitumen to tar on account of its cheapness and of the fact that less technical skill is required in its heating and application, as greater liberties can be taken in this respect.

The Victorian Country Roads Board, on the other hand, is exacting in the extreme in the rigidity of its Specifications, and possesses an excellent organization and a thorough knowledge of the latest methods of road construction. It is significant that it is the only large road tar customer we have retained.

In New Zealand, where the price of bitumen is more favourable to the tar distiller, Bitural is obtaining an increasing share of the business.

The tremendous falling off in tar sales for road construction purposes has forced the Metropolitan Gas Company to sell large quantities of tar as fuel; thus we have become purveyors of solid, liquid, and gaseous fuels.

Early in 1933 we commenced supplying tar to a large Woollen Mill for boiler fuel. The tar replaced oil fuel, and a total of 2,610,000 gal. was delivered up to the end of 1935, when the business was lost to New South Wales slack coal at a phenomenally low price.

A contract has been made recently with an Iron Rolling Mill for the supply of one million gal. of tar per annum in place of fuel oil.

The disposal of tar as fuel may be regarded as an expedient until further avenues, which would raise its status as an asset to the Gas Industry, are explored. It will be clear from the analysis and figures given in the section on complete gasification that continuous vertical retort tar is more valuable as a carburetting medium than as a fuel or road binding material. Its composition would also suggest that it is an excellent raw material for hydrogenation.

GAS MANUFACTURE IN MELBOURNE.

Ten years ago gas was manufactured at three Works, viz., West Melbourne (on the River Yarra), with an approximate capacity at that time of 10 mill. cu.ft. per day, South Melbourne (near Hobson's Bay), 5 mill. cu.ft. per day, and Fitzroy (in the centre of the City), 2½ mill. cu.ft. per day. There is no necessity to detail the plant in use at that time, as the Fitzroy Works have been closed permanently and the South Melbourne Works were closed for nearly 3½ years during the depression following 1929.

It is sufficient to state that since 1928 the whole of our horizontals (4 mill. cu.ft. per day), inclined (5 mill.), and a bench of intermittent vertical retorts (1 mill.) have been scrapped. The total amount standing in capital account against this plant, viz., £219,389, has been written off.

Continuous Vertical Retorts.

The West Melbourne plant now consists of a 10 mill. cu.ft. per day continuous vertical retort installation, to which has been added a 5 mill. carburetted water gas plant.

The continuous verticals are of the downwardly heated type. Four of the five units are built of local (Darley) fireclay material which will stand hard usage up to 1,300° C. Top heating gave very little trouble with this material.

In 1929, No. 3 unit was reconstructed in English silica. Owing to spalling between 4 ft. 6 in. and 8 ft. 6 in. down the retort the silica was completely worn through in three years. Repairs were effected in Scotch silica, which failed in even less time—2½ years. The temperature at the point of failure averaged 1,400° C. when new with English silica, and after repairs with Scotch silica, 1,350° C. Further repairs have been made in New South Wales silica, which after twelve months shows no signs of deterioration. It should be remarked, however, that lower temperatures have been carried, not exceeding 1,250° C.

This experiment, which cost at least £15,000, proved that, considering the lower cost and longer life of local fireclay material, no commensurate advantage is to be gained by using silica material when carbonizing rich coal such as Maitland in downwardly heated retorts. In fact, apart from the foregoing, the higher temperatures in lightly steamed continuous verticals caused degradation of the gas, with heavy loss through scurf production and removal. With the top heating type of plant and Maitland coal, steaming beyond a very restricted point is much less efficient than the direct production of gas in modern water gas plant.

After nine years' work No. 5 unit is now being renewed in Darley material with Vulcan bricks (made in New South Wales) at the top of the retorts. It is expected that this unit will have a life of ten years with minor repairs after five years' working.

Chamber Ovens.

At South Melbourne a 1½ mill. cu.ft. per day intermittent vertical retort plant has been converted to a 2 mill. chamber oven unit. It is proposed later to convert the remaining intermittent vertical retort plant to ovens so that the coal gas plant at South Melbourne will eventually consist of vertical ovens only. This type of plant, in the short period it has been at work, has created a very favourable impression on account of its smooth working and increased therm production and, as a conversion, should prove a very good commercial proposition. Practically no time off is required for scurfing with this plant.

In lieu of silica it was decided to erect the first vertical oven installation in the local firebrick material which has given so many years of good service. With moderate steaming the production per ton of coal averages over 90 therms of 545 B.Th.U. gas, which, considering that the temperature is restricted to 1,300° C., is extremely satisfactory.

The makers of the local firebrick material (Darley Firebrick Company) are at present experimenting with an improved firebrick—a mixture of Darley fireclay and local bauxite—which it is hoped will stand up to 1,400-1,500° C. It is expected that no expansion troubles will be experienced with the new material and, if this is proved to be the case, it would appear to be exactly what we have been seeking as a brick for use with high temperatures.

It is anticipated that the price will be about the same as that of New South Wales silica.

Carburetted Water Gas Plant.

The carburetted water gas plant at West Melbourne, which has worked continuously since its installation in 1929, is without question the most perfect piece of gas producing plant yet devised. The therm production for 1936 represented 21 per cent. of our total make and, although coke was charged to the water gas plant at 32s. 9d. per ton as against the average selling price of 23s. per ton for coke and breeze, there was a saving of £3,250 as compared with the equivalent cost per therm in the vertical retorts, after taking into account provisions for plant renewal. It has to be admitted that the calorific value of the vertical retort gas was 606 B.Th.U. as against 412 B.Th.U. of the water gas; although while working on South Yorkshire coal during the 1929 coal strike the calorific value of the water gas was maintained at 550 B.Th.U., by the use of fuel oil costing 4d. per gal. at a cost less than that of gas of equivalent calorific value produced from the same coal in vertical retorts. But the direct saving is only a small part of the total advantages derived from the manufacture of water gas in Melbourne which may be summarized briefly as follows:—

1. Utilization of coke by which the price can, to a great extent, be maintained. Fifty thousand tons of coke per annum have been taken off the local market, a portion of which previously had to be sold at cut rates. This factor, together with the high price charged for coke to the water gas plant, has resulted in an amount estimated at £12,000 per annum being deducted from the cost of coal and reflected in the coal gas production costs which should really be credited to water gas manufacture.
2. Less production of vertical retort tar, at present a drug on the market in Victoria.
3. Plant may be put into action and calorific values regulated almost immediately.
4. Being completely automatic, few men are required. The operators in Melbourne are on the Staff and eligible for superannuation upon retirement; they are not members of any industrial organization.
5. Obviates the necessity of carrying coal stocks to the equivalent of its gas production—in our case, assuming a three months' supply, 14,500 tons.

The only serious disadvantage of carburetted water gas plant is in connection with the continual burning out of carbon and rechequering in the carburettors, causing considerable loss of heat units and time.

Complete Gasification Plant.

During the past twenty years it has been the Author's increasing conviction that the solution of our main problem in Australia, that is, a balanced production and sale of gas and residuals, lies in the direction of complete gasification. It was not until two years ago, however, that we were in a position to attempt the design of a pilot plant capable of gasifying any type of solid and liquid fuel to produce a gas suitable for town supply.

The problem for investigation was to ascertain the practical possibility of operating a complete gasification plant, which it was proposed should consist of three simple generators, in such a manner that a continuous production of gas was ensured. The operations were to be so synchronized that while the first generator was blowing, the second in series would be up-running and the third down-running. At the change of cycle the one that had been down-running would go on to the blow, the one that had been blowing would go on to the up-run, and the one that had been up-running would go on the down-run. Thus they would be operated in rotation, each being subjected to precisely the same conditions. Immediately a generator commences to up-run, fuel is added to that generator and the volatile matter from the fuel expelled during the periods of up-run and down-run. When a generator is down-running, tar or oil is cracked to gas by spraying it on to the surface of the fuel bed of that generator, carburetting the gas to any desired calorific value.

The aims of the experimental work were to determine:

(*a*) whether the volatile matter in the coal would be released during the up-run and down-run periods,
(*b*) the relationship in time taken to release the volatile matter from the coal and the subsequent gasification of the coke produced,
(*c*) the correct temperature to which the down-running generator must be reduced to produce correct cracking conditions,
(*d*) if the gum-forming hydrocarbons are reduced or eliminated in passing through the fuel bed of the down-running generator,
(*e*) the extent to which the gas could be carburetted with tar or oil,
(*f*) the make of gas per ton from various fuels,
(*g*) if this process of complete gasification is particularly applicable to brown coal and to what extent the high CO_2 content of this gas is reduced in the down-running generator.

During the first twelve months' working the pilot plant was operated manually and, owing to the large number of movements per cycle, three men at a time were necessary for operating the plant and collecting data. During this time tests were run with the operators working for 24 consecutive hours. This was an unreasonable time for men to be on duty and as no other suitable operators were available it was impossible to conduct tests for any longer period. It was therefore decided to install an automatic operating device for further experimental purposes and thereby convert the plant to a continuously operating small works model with an approximate output of 75,000 to 100,000 cu.ft. per day. The cost of the pilot plant was £1,880, including £800 for the automatic gear. The plant is shown in fig. 1.

The Complete Gasification of Solid Fuels.

Before producing a carburetted gas many experiments were carried out using various coals alone. The coals selected covered a wide range from non-caking to highly caking, low ash to high ash, low volatile to high volatile and both brown and bituminous.

Naturally the freer the fuel bed the greater the make per hour. The American coal gave some trouble in the fuel bed and the make per hour from this coal was lower than with other black coals. In the case of raw brown coal the steam was decreased owing to the high moisture content of the coal itself, in order to reduce the CO_2 content in the resultant gas. Brown coal briquettes produced an excellent fuel bed. They were very active in their reaction with the steam, and the bed was at all times particularly free, allowing an easy passage for both steam and gas. No poking of the beds was required. The only difficulty likely to arise from this fuel is the carrying forward of the light dust and ash, and its accumulation in mains, valves, &c.

The tar evolved from the high volatile coals gave at times a little trouble in the operating and stack valves. The surface of the fuel bed needed attention every 2 hr. Somewhat unexpectedly the low volatile coals, though highly caking, gave no trouble; there was plenty of room for them to swell and as they were not confined, as in a retort, the coke was neither dense nor large and permitted the ready penetration of both steam and blast.

Analyses of the fuels used in the actual experiments and results of the complete gasification tests are given in Tables 2 and 3.

The Production of Carburetted Gas.

To demonstrate the practical nature of this process it was deemed advisable to produce 500,000 cu.ft. of each particular carburetted gas, *i.e.*, approximately a week's continuous run of the plant.

Three combinations were chosen as typical examples and for their practical significance to my Company. Melbourne is surrounded by brown coal deposits and residual oil is available in any quantity at a reasonably low price.

These three combinations were:—

1. Brown coal briquettes and oil.
2. Maitland coal and tar.
3. Coke and tar.

If a 500 B.Th.U. gas could be obtained with brown coal and oil, then it could be obtained with any other fuel and oil. The results from brown coal and tar would be somewhere about 20 B.Th.U. higher than coke and tar for the same quantity of carburetting medium.

It will be noticed from the results that the make per hour when using brown coal and oil considerably increased over the make when using brown coal alone; the make per hour with coke and tar was also very high, but when using bituminous coal and tar the make per hour decreased. Less trouble due to blockages was experienced when making carburetted gas than when producing straight gas from the coal. Minor dust and carbon troubles that were experienced previously were evidently prevented by the

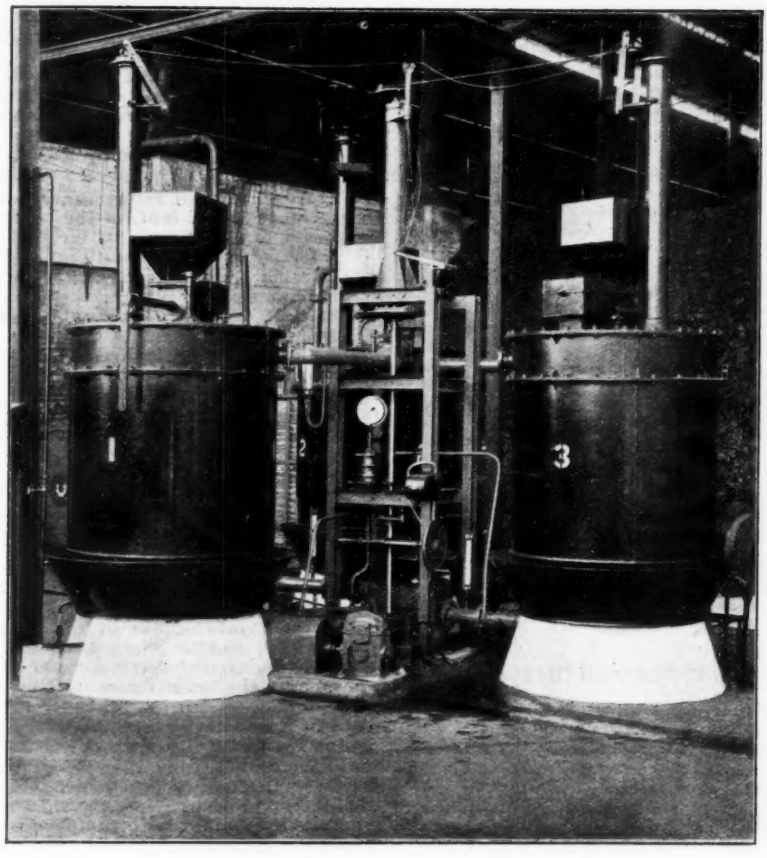


FIGURE 1.—*Complete Gasification Pilot Plant.*

TABLE 2.—*Analyses of Fuels Used in Complete Gasification Experiments.*

—	Coke.	Maitland Coal: Aberdare.	Illawarra Bulli Coal.	English Coal: Easington, Durham.	U.S.A. Coal: Youghiogheny	Brown Coal Briquettes: Yallourn.	Raw Air-Dried Brown Coal: Gelliondale.
1	2	3	4	5	6	7	8
Moisture per cent.	7·50	2·65	1·43	1·68	1·85	13·00	20·00
Ash ,,	6·73	4·34	9·06	6·13	5·09	1·66	6·36
Volatile matter ,,	2·43	42·09	24·30	31·87	34·93	44·88	35·20
Fixed carbon ,,	83·34	50·92	65·21	60·32	58·13	40·46	38·44
Calorific value (dry basis), B.Th.U. per lb.	12,900	13,820	13,700	13,850	14 050	10,980	10,200
Therms (dry basis)	289	310	307	310	315	246	228
Properties		Slightly caking	Highly caking	Very highly caking	Highly caking	Non-caking	Non-caking

TABLE 3.—*Results of Complete Gasification of Various Coals.*

—	Brown Coal Briquettes.	Raw Brown Coal.	Maitland Coal.	Bulli Coal.	Durham Coal.	American Coal.
1	2	3	4	5	6	7
Quantity of coal used, tons	7·35	1·92	5·76	1·54	2·9	2·91
Gas produced, cu.ft.	290,880	74,400	351,000	88,000	170,000	161,280
Calorific value of gas produced, B.Th.U. per cu.ft.	312	306	325	315	324	350
Therm yield per ton	123·46	118·53	197·9	179·9	191·16	193·6
Make per ton of coal, cu.ft.	39,570	38,700	60,900	57,100	59,000	55,300
Average make of gas per hour, cu.ft.	4,040	3,100	3,510	3,670	3,500	3,360
Make per 24 hours, cu.ft.	96,960	74,400	84,240	88,000	85,000	80,640
Average analysis of gas—						
CO_2 per cent.	5·5	6·8	2·6	3·6	3·9	3·9
O_2 ,,	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
C_nH_m ,,	*Nil*	*Nil*	*Nil*	*Nil*	0·3	0·3
CO ,,	36·5	36·0	30·9	39·7	31·7	32·1
CH_4 ,,	4·0	2·6	4·0	2·3	4·5	6·6
H_2 ,,	48·2	46·0	53·8	47·5	49·9	51·3
N_2 ,,	5·8	8·6	8·7	6·9	9·7	5·8
Density	0·550	0·580	0·490	0·550	0·520	0·510

presence in the gas of residual tar produced from oil or tar enrichment in the gas.

The results from carburetting are given in Table 4.

TABLE 4.—*Results of Experiments in the Production of Carburetted Gas.*

1.	Test No.	1	2	3
2.	Type of solid fuel used	Brown Coal Briquettes.	Maitland Coal.	Coke.
3.	Nature of carburettant	C. O. R. Residual Oil.	Vertical Retort Tar.	Vertical Retort Tar.
4.	Cal. value of coke, black coal, or brown coal water gas, B.Th.U. per cu.ft.	313	331	298
5	Quantity of solid fuel used, tons	10·8	6·8	7·4
6.	Quantity of carburettant used, gal.	894	1,385	1,344
7.	Total quantity of gas produced, cu.ft.	507,753	500,080	517,000
8.	Total make of gas per ton of solid fuel charged, cu.ft.	47,000	73 530	70,000
9.	Quantity of tar or oil gas produced, cu.ft.	71,520	62,325	70,000
10.	Gas produced minus tar or oil gas, cu.ft.	436,233	437,755	447,000
11.	Gas produced per ton of solid fuel plus tar coke, cu.ft.	..	64,400	60,400
12.	Gas produced from tar coke, cu.ft.	..	5,400	2,400
13.	Approximate make of coal or coke water gas, cu.ft	..	59,000	58,000
14.	Tar or oil used per 1,000 cu.ft. of gas, gal.	1·76	2·77	2·60
15.	Average calorific value of gas produced, B.Th.U. per cu.ft.	502	516	463
16.	Increase in calorific value due to tar or oil gas, B.Th.U. per cu.ft.	189	185	165
17.	B.Th.U. in the form of gas per gal. of tar or oil	107,400	66,800	63,400
18.	Residual tar recovered per gal. of tar or oil used, per cent.	12	30	30
19.	Average make of gas per hour, cu.ft.	4,500	3,210	4,650
20.	Average analysis of gas produced—			
	CO_2 per cent.	6·8	2·0	3·6
	O_2 ,,	*Nil*	*Nil*	*Nil*
	C_nH_m ,,	4·7	4·2	3·5
	CO ,,	23·9	27·8	30·6
	CH_4 ,,	11·4	10·8	9·8
	H_2 ,,	49·6	51·0	48·6
	N_2 ,,	3·6	4·2	3·9
	Density	0·543	0·487	0·530

NOTE: (*a*) It was ascertained from experiments that the oil yielded 80 cu.ft and the tar 45 cu.ft. of gas per gal.
(*b*) A determination for naphthalene was made on the tar carburetted gas but naphthalene was found to be absent.

Comments.

Brown Coal Carburetted Gas.

The fuel beds were very free during the entire run, permitting free access of steam, air and gas. Thus good makes were obtained; in fact, the makes per hour exceeded those obtained when using brown coal without the oil. There were no blockages and the beds did not require any attention.

Maitland Coal and Tar.

Bituminous coal does not form such a free fuel bed as brown coal owing to a slight tendency to cake; thus it was necessary to rod the surface of the bed every 2 hr. The caking qualities of the coal plus the large quantity of tar added—an amount in liquid fuel equivalent to that of solid fuel—somewhat impeded the passage of steam and gas through the fuel bed. The lower make per hour, however, permitted a 500 B.Th.U. gas to be obtained with very little trouble. The installation of a rotary grate should overcome this difficulty.

Coke and Tar.

This combination proved the best for gas making capacity. The beds were particularly free, permitting greater use of steam, and the make of gas per hour exceeded that previously obtained with any other combination of fuels. The large make of gas per unit of time, however, rendered it impossible in the pilot plant to add the requisite quantity of tar to carburet the gas to 500 B.Th.U. With a generator of larger diameter and more tar sprays this objective should be obtainable.

Advantages.

1. Simplicity and cheapness of generator design.
2. Flexibility in the variety of solid and liquid fuels it will gasify.
3. Flexibility in operation to permit of definite rates between coal feed, and evolution of volatile matter and subsequent gasification of the resultant coke.
4. Carburetting on the fuel bed without the necessity of carburettor and superheater.
5. Particularly adapted to gasification of brown coal and the production of tar-carburetted gas.
6. Production of a more permanent gas, free from oxygen, which is lower than other systems in gum-forming constituents and inert content.
7. Production of an improved residual tar.

When vertical retort tar is used as a carburetting medium 30 per cent. of the tar introduced is returned in the form of a residual tar. This residual tar is very interesting in composition. Hydrocarbons of the paraffin series present in the original tar are absent, naphthenes are absent, the unsaturated hydrocarbon content has been considerably reduced, and the higher boiling phenolic bodies have been reduced to the lower boiling and more valuable phenol. This tar is highly aromatic, being rich in benzene, toluene, xylene, phenol, naphthalene, and anthracene. It thus becomes a more valuable product not only to the tar distiller, but to the nation as a superior raw material for the chemical industries associated with dyestuffs, plastics, and high explosives.

Conclusions.

At the termination of two years' experience on the operation of this process and plant we are of the opinion that technically it is fundamentally sound and that the surprisingly few troubles experienced were purely mechanical in nature and can be easily overcome.

The fuel costs of gas in the pilot plant are given in Tables 5, 6, and 7. The cost of coal is taken at approximately the average over a term of years, and coke is charged at the same figure. The brown coal briquettes were obtained from the State Electricity Commission, but the raw brown coal was supplied by a privately owned mine and is reputed to be of a somewhat different nature. The results obtained from raw brown coal were considerably better than appeared probable. Check tests were run on this fuel, and in each case the therm yield was abnormally good. It is difficult to sample raw brown coal satisfactorily, so that the moisture content may have been lower than the figure given in the analysis. Owing to its inherent moisture, however, less steam was used when gasifying this coal, so that the hydrogen liberated from the moisture content might increase the gas yield.

A plant to manufacture about ½ mill. cu.ft. per day has been designed which it is proposed to erect at South Melbourne Works, where there is no water gas plant and the cost of coal reception is higher than at West Melbourne Works.

Cost of Gas Production in Complete Gasification Plant.

	s.	d.	
Coal	30	0	per ton
Coke	30	0	,, ,,
Brown Coal Briquettes	17	6	,, ,,
Raw Brown Coal	12	6	,, ,,
Tar	3		,, gal.
Carburetting Oil	4		,, ,,
Gas Yield from Tar	50		cu.ft. per gal.
,, ,, Oil	80		,, ,,

TABLE 5.—*Cost of Production of Water Gas from Various Fuels.*

—	Coke.	Coal.	Brown Coal Briquettes.	Raw Brown Coal.
1	2	3	4	5
Make of gas per ton of fuel, cu.ft.	59,000	60,000	39,500	38,700
Calorific value, B.Th.U. per cu ft.	298	325	31[illegible]	306
Cost per 1,000 cu.ft., pence	6·1	6·0	5·01	3·88
Cost per therm, pence	2·05	1·85	1·60	1·27

TABLE 6.—*Cost of Production of 500 B.Th.U. Tar-Carburetted Gas from Various Fuels.*

—	Maitland Coal.	Brown Coal Briquettes.	Raw Brown Coal.
1	2	3	4
Make of gas per ton of fuel, cu ft.	60,000	39,500	38,700
Tar added per 1,000 cu.ft., gal.	2·6	2·8	2·9
Tar added per ton of fuel, gal.	156	112	116
Tar coke produced, lb.	212	[illegible]8	184
Gas made from tar coke, cu.ft.	5,300	4,450	4,600
Tar gas produced, cu ft.	7,800	5,600	5,800
Total yield of gas, cu.ft.	73,100	49 550	49,100
True cost of total gas without cost of tar per 1,000 cu.ft., pence	4·95	4·00	3·06
Cost of tar per 1,000 cu.ft., pence	7·80	8·40	8·70
Gross cost of gas per 1,000 cu.ft., pence	12·75	12·40	11·76
Value of tar recovered, pence	2·60	2·80	2·90
Net cost of gas per 1,000 cu ft., pence	10·15	9·60	8·86
Net cost of gas per therm, pence	2·03	1·92	1·77

TABLE 7.—*Cost of Production of 500 B.Th.U. Oil-Carburetted Gas from Various Fuels.*

—	Coke.	Maitland Coal.	Brown Coal Briquettes.
1	2	3	4
Make of gas per ton of fuel, cu ft.	59,000	60,000	39 500
Oil added per 1,000 cu.ft., gal.	2·0	1·75	1·76
Oil added per ton of fuel, gal.	118	105	70
Oil gas produced, cu.ft.	9,440	8,400	5 600
Total yield of gas, cu.ft.	68,440	68,400	45.100
True cost of total gas without cost of oil per 1,000 cu.ft., pence	5·2	5·1	4·39
Cost of oil per 1,000 cu.ft., pence	8·0	7·0	7·04
Gross cost of gas per 1,000 cu.ft., pence	13·2	12·1	11·43
Value of tar recovered, pence	1·0	0·88	0·88
Net cost of gas per 1,000 cu.ft., pence	12·2	11·22	10·55
Net cost of gas per therm, pence	2·44	2·24	2·11

CONDENSATION, WASHING, AND DEHYDRATION.

It is becoming more fully realized that a factor of prime importance in the stabilization of gas is the removal of all impurities of a corrosive and otherwise detrimental nature.

In modern gas practice, condensing, washing, and purifying do not seem to have shared, to an equal extent, the research and progress that has characterized the development of other technical branches of the Industry. Ordinary methods of washing and purification leave in the gas substances which create much avoidable trouble in the distributing system and subsequent inconvenience to the consumer.

Gas resulting from the carbonization of high volatile Maitland coal in continuous vertical retorts contains a high percentage of light oil in the form of vapour and fog, and if the washing plant is inadequate the oxide becomes contaminated with this material and its activity is impaired in consequence. Any ammonia that may go forward, in excess of what is required to maintain normal alkalinity, results in the formation of ammonium sulphocyanide which also reduces the activity of the oxide.

In Melbourne particular attention has been paid to the condensing and washing portion of the plant. Although in Victoria, during the summer months, the temperature of the feed water to the washers is frequently above 70° F., the ammonia figure for 1936 has been maintained at an average of 0·39 grains per 100 cu.ft. This low ammonia content has been brought about at West Melbourne Works by the Holmes Dri-Gas Plant, and at South Melbourne Works by an intense cooling plant of the Dr. Lenze type. The removal of ammonia by the Holmes plant at West Melbourne is incidental to the process, but in the intense cooling plant at South Melbourne it is naturally a direct result. The average daily maximum and minimum temperatures of the gas at the outlet of the intense cooling plant during 1936 were 44·8° F. and 39·6° F. respectively.

The figures for 1936 in connection with the removal of impurities by the South Melbourne plant, with an average make of 1½ mill. cu.ft. of gas per day, are instructive:

Average water extraction	61·6	per cent.
Average organic sulphur compounds in gas before cooler	13·73	gr. per 100 cu.ft.
Average organic sulphur compounds in gas after cooler	9·26	,, ,,
Reduction in organic sulphur compounds	32·6	per cent.
Average naphthalene content in gas before cooler	7·04	gr. per 100 cu.ft.
Average naphthalene content in gas after cooler	0·35	,, ,,
Reduction in naphthalene content of gas	95	per cent.
Average gum forming constituents in gas before cooler	5	gal. per mill. cu.ft.
Average gum-forming constituents in gas after cooler	2·5	,, ,, ,,
Reduction in gum-forming constituents	50	per cent.

The experience we have gained has led us to the belief that an extension of the intense cooling process could be made to perform a dual purpose, viz., to reduce the temperature of the water in the washing system and to dehydrate the gas subsequent to purification. This would have the effect of increasing the capacity and efficiency of the washers and reducing the percentages of water, ammonia, naphthalene, organic sulphur compounds and gum-forming constituents to a degree in which they become innocuous.

It appears within the bounds of practicability that condensing, washing, and dehydration may be carried out conjointly by this process to an extent sufficient to eliminate the major portion of our distributing troubles and thus render our commodity as free from minor irregularities as its chief competitor.

CONSTRUCTION DEPARTMENT.

The Company is unique inasmuch as it constructs most of its plant in its own workshops, only very specialized machinery such as boilers, turbo-blowers, motors, and the like being obtained from other sources.

Though the Company's workshops do not approach British organizations in size, they are probably as well laid out and equipped for their purpose. The structural workshop is 220 ft. long by 90 ft. wide and 20 ft. high at the eaves, and the fitting shop is 100 ft. long by 56 ft. wide and 30 ft. high. In addition, there are also pattern-makers', electricians', and carpenters' shops. These workshops are steel-framed structures designed for maximum natural light.

The fitting shop is well equipped with machine tools, though modern machines are being added from time to time. In the structural workshop the department's pioneering work in electric welding and flame cutting has led to a complete re-casting of the whole idea of structural shop equipment; and consequently, as no riveting whatever is done, the layout and equipment differ to some degree from those found in other establishments.

Probably the most interesting work, from a purely constructional point of view, is seen in the Company's new plant and buildings. The pioneering work done with electric arc welding and flame cutting, which dates back to 1920, has led to the development of a special technique in the design of steel structures with consequent distinctive features which are peculiar to the Company's plant. The department has built ten arc-welded gasholders, including four of 3 mill., three of 1 mill. and three of ½ mill. cu.ft. capacity. In other directions there are arc-welded retort houses, purifiers, condensers, coal and coke handling plant, &c.

THE GAS REGULATION ACT, 1933.

Prior to 1933 Gas Undertakings in Victoria had no powers to insist on gas fitting work being carried out in a proper manner; neither was there any safeguard to protect the Public from work being undertaken by incompetent men. For many years past the Metropolitan Company has been compelled in its own interests to engage extensively in gas fitting work.

The Gas Regulation Act, 1933, was passed by the Victorian Parliament primarily for the purpose of bringing up to date the provisions for quality, purity, pressure, and testing of the gas. Power was also given in the new Act to Gas Undertakings to frame regulations for the proper installation of gas fittings and apparatus. Clause 9 of the Act reads as follows:

> "An undertaker shall not be compelled to give or continue a supply of gas to any premises unless the fittings therein are installed in accordance with regulations duly made by the undertaker and approved by the Minister."

The National Gas Association of Australia appointed a committee to draft Gas Fitting Regulations which were placed before the Minister and adopted by him. The Regulations came into operation on the 1st January, 1936, and provide that every outside plumber and gas fitter must give to the Gas Undertaking a Preliminary Notice of his intention to carry out gas fitting work in its area of supply. Each job is then inspected by an authorized officer of the Gas Undertaking, who fixes the position of the meter or meters, and lays out the work in consultation with the plumber. After completion, the pipe lines are subjected to a pressure test, and not until the installation is proved satisfactory are the gas supply and meter connected thereto. The responsibility for enforcing the Regulations devolves upon the Gas Undertaking, and thereby we have complete control of the situation. The results obtained after a year's working have been very satisfactory indeed, and gas consumers are now assured that all installations conform to standard requirements.

Another factor which has considerably helped to place gas fitting on a higher plane is the fact that under the Health Acts all plumbers and gas fitters must be registered as such by the Plumbers and Gas Fitters Board before they are permitted to engage in plumbing and/or gas fitting work in any city, town, or borough within the State of Victoria. Before registration, the particulars of the training and experience of every applicant are carefully scrutinized by the Board, and none other than a competent tradesman is accepted as eligible for registration.

The new order has changed the situation considerably, and to-day many outside firms carry out first-class gas fitting work in Melbourne. This is to the advantage of the Gas Industry, as the growth of outside interests is reflected in increased sales of appliances.

The calorific standard of the gas was fixed at 500 B.Th.U. gross for all Undertakings in Victoria sending out over 25,000,000 cu.ft. per annum. To the Author the time ap-

pears ripe for a consolidation of calorific values in Great Britain. It would be difficult to advance sound reasons why suppliers should require to send out gas over the present range of calorific values. It is a fair assumption that the damage done in distributing systems by undesirable constituents of low grade gas produced in the usual way outweighs any benefits conferred by latitude which is presumed to be of such value. It would be to the advantage of consumers and of immense benefit to appliance manufacturers if calorific standards were confined to alternatives of, say, 500 or 400 B.Th.U. gross.

SALE OF GAS.

Basis of Gas Tariffs.

Every year new tariff schedules are introduced in the Gas Industry, each seemingly more complicated and confusing to the consumer than the method it displaced. To the technical mind there can be no justification other than that of expediency for basing a service charge on the rateable value of a property or the number of rooms contained therein. A fairer basis would seem to be a charge to cover the interest on the capital expenditure required to supply consumers.

Assuming that the capital employed per 1,000 cu.ft. sold in an Australian Undertaking is £1, the average consumption 24,000 cu.ft. per annum, and the rate of interest on the money invested in the concern 5 per cent., each consumer should provide 24s. per annum as a service charge.

This would, with a monthly account system, be added to the first block. So that if the average overall cost of supplying gas minus the interest charge was, say, 5s., the first 1,000 cu.ft. would be at the rate of 7s. per thousand.

The next block, 1,000 cu.ft., which, added to the previous block, would cover the basic consumption per annum and no doubt retain the cooking load, would be at the average cost of supplying gas—5s.

The third and last block, for all gas over 2,000 cu.ft. per month, would be at the lowest possible rate in order to render the capture of water and space heating practicable.

The minimum charge is 2s. per month.

Incidentally, in Melbourne, following the introduction of the minimum monthly charge of 2s., orders were given to remove 862 meters in 1934, 276 in 1935, and 85 in 1936—a total of 1,223 meters in 2½ years. The average monthly consumption lost by these removals was less than 100 cu.ft., so that the Company has actually profited by the introduction of the minimum charge.

The commodity charge to very large consumers should receive special consideration based on the position of the Undertaking having regard to available plant and production costs. Much is heard of keeping in operation surplus plant, but little is said as to the position which will arise when all plant is in use and additional large consumers become unprofitable at severely cut rates.

Whether there is, or is not, any merit in the ideas put forward, it cannot be gainsaid that there is urgent need for consolidated methods regarding rate structure.

PROMOTION OF GAS AND APPLIANCE SALES.

The Head Office, on the reconstruction and furnishing of which £60,000 was spent in 1933-34, has a very fine showroom and demonstration theatre on the ground floor, also industrial and commercial sales departments.

The Company has no less than seventeen suburban showrooms.

It is now fully realized by progressive Companies that the promotion of gas and appliance sales is a task for the specialist. In 1934 a Controller of Sales was appointed by the Metropolitan Company. This officer was entirely new to the Gas business—in fact, he came from our principal oil competitor.

There is every indication that the re-organization and modernization of this department will be an unqualified success, which, taken in conjunction with the complete gasification results herewith enumerated, suggests that the economical production and sale of gas alone presents less difficulty than the unnecessarily complicated situation now in existence.

The modern tendency towards clean automatically controlled fuel leads one to the inevitable conclusion that future concentration on our main product, Gas, could have no result other than a beneficial consolidation of our interests.

THE ESTIMATION OF Nitric Oxide in Gas

Communication No. 154

by
H. HOLLINGS
(Chief Gas Chemist, Gas Light and Coke Company)

INTRODUCTION.

In a previous Paper* presented to the Institution on "The Formation of Nitrogenous Gum during the Storage and Distribution of Gas" reference was made to an apparatus for the continuous estimation of nitric oxide in coal gas. This apparatus is now made by Griffin and Tatlock, Limited, and is illustrated in fig. 1.

METHOD.

As in the "spot" test, the method for the continuous estimation of nitric oxide is based on that of Guyer and Weber† in which nitric oxide is oxidized with acid potassium permanganate, the oxidized product trapped in Griess reagent and the resulting colouration matched against the colour produced by adding a standard solution of sodium nitrite to the original, uncoloured Griess reagent.

Dust-free crude gas, adjusted to a constant pressure by allowing part of it to bubble out to air through butyl phthalate (chosen because of its low vapour pressure) in a bubbler B, passes through a capillary C. The head of butyl phthalate is adjusted to give a rate of flow of about 0·5 cu.ft. of gas per hour. The gas passes upwards round a glass spiral A, down which is flowing the caustic soda solution (i). If the gas to be tested be purified gas containing very little gum, no caustic soda need be used, while for some crude gases containing high concentrations of ammonia, it may be necessary to insert an acid wash bottle between spirals A and G, or at the inlet to the apparatus.

The rate of flow of the caustic soda solution is fixed at 35-45 c.c. per hour by controlling the flow of air into the solution by adjustment of the length of the capillary tube D. The gas thus freed from hydrogen sulphide and hydrogen cyanide then passes through a small head of acid permanganate at E. The sludge formed at this point falls into the tube F, from which it can be drained. The gas passing up the spiral G is scrubbed by acid potassium permanganate. The flow of the permanganate is controlled at about 70-80 c.c. per hour by adjustment of the capillary H. The gas passes up the tube J, which prevents flooding in the event of a blockage of the spiral, and into the Griess scrubber K, where the oxidized nitric oxide is removed. The coloured Griess reagent flows into the large bulb L, where it is stored, protected from light. The rate of flow of the Griess reagent is adjusted to 35-45 c.c. per hour by means of the capillary M.

After leaving the Griess scrubber, the gas passes through a trap tube T containing soda-lime and through the gas meter out to air.

The air entering each solution is caused to pass through barium peroxide hydrate in the U-tubes N, N, N to remove nitric oxide in the air. Barium peroxide hydrate may be prepared by spreading a paste of anhydrous barium peroxide and water on a tile, leaving it to set and later breaking the mass into small pieces.

REAGENTS.

The necessary reagents are:

(*a*) Distilled water free from oxides of nitrogen.*

(*b*) A solution of sulphuric acid (25 per cent. by weight).

(*c*) A solution of potassium permanganate (2·77 per cent. by weight).

(*d*) A solution of acid permanganate. This should be prepared as required by mixing one part by volume of (*b*) with nine parts of (*c*).

* See Communication Inst. Gas Eng., 1936, **147**, 50.

* H. Hollings; Communication Inst. Gas Eng., 1936, **147**, 51.

† A. Guyer and R. Weber; Brennstoff Chem., 1933, **14**, 405.

(*e*) A solution of sulphanilic acid. 600 ml. of (*a*) are boiled and 4 g. of sulphanilic acid added. After cooling, 200 ml. of glacial acetic acid are added and the solution made up to one litre with (*a*).

(*f*) A solution of alpha-naphthylamine. 2·52 g. of the material are dissolved in 200 ml. of cold glacial acetic acid and the volume made up to 1 litre with (*a*). This solution is kept in a coloured bottle.

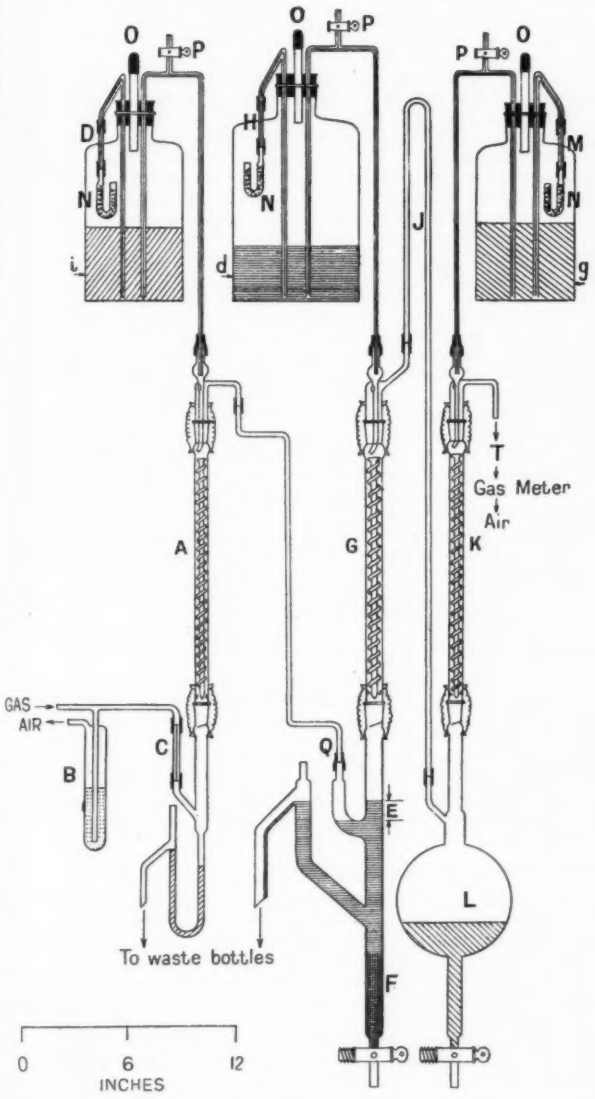


FIGURE 1.—*Apparatus for the Continuous Estimation of Nitric Oxide in Gas.*

(*g*) A solution of Griess reagent. One part by volume of (*e*) is mixed with one part of (*f*) and then diluted to 14·3 parts with (*a*). This solution should be made up when required and not stored prior to use.

(*h*) A solution of sodium nitrite (Analar) containing 0·027 g. per litre.

(*i*) A solution of caustic soda (10 per cent. by weight).

OPERATION.

The solutions are poured into the bottles through funnels placed in the wide tubes (O) fitted through tightly-fitting rubber stoppers. The flow of solutions is started by the application of pressure through O; the rubber caps are then replaced. The flow of solutions may at any time be stopped by opening the taps P, P, P.

After gas and reagents have passed through the apparatus for at least half-an-hour, Griess reagent is flushed down the last spiral. This can be done most effectively by removing the rubber cap on the reservoir bottle. The reagent is drained through the tap, the latter closed, and the gas meter read. The apparatus is then left running for such a period as is required (*e.g.* ½ hour to 48 hours). At the end of this period the Griess reagent is again flushed down the spiral, drained out of L into a measuring cylinder and the meter read. The volume of the coloured Griess reagent is measured (V ml.) and 100 ml. of the solution transferred to a Nessler glass. 100 ml. of the unused reagent from the reservoir are placed in a similar Nessler glass and solution (*h*) is added from a 1 ml. micro-burette until the same depth of colour is produced as in the test solution. As the colour develops slowly, five minutes should elapse before each addition of nitrite is made and fifteen minutes before the final matching.

If the volume of gas passed be X cu.ft. at 60° F. and 30 in. mercury, saturated with water vapour, corrected, if required, for loss of carbon dioxide and other substances, and if the volume of nitrite solution be Y ml., then the concentration of nitric oxide in parts per million is obtained from the following expression:

$$\text{Nitric oxide, p.p.m.} = \frac{\text{V.Y.}}{100.\text{X}}$$

When changing over from one gas to another, the caustic soda and the permanganate solutions, as well as the Griess reagent, should be flushed down the spirals by removing the rubber caps, and the permanganate drained away before starting a new run.

Before the permanganate spiral finally chokes with the accumulation of sludge, the rubber connection Q and the springs on the bottom joint are removed and the bottom section slid down in the clip until the column can be removed for cleaning with sulphur dioxide or a hot solution of oxalic acid. A spare spiral is then fitted in the apparatus and used until it also requires cleaning.

All ground joints should be lubricated with Adeps Lanæ or other suitable tap grease.

RESULTS.

The apparatus has been found to give good agreement with the "spot" test. With gases containing high concentrations of hydrogen sulphide, hydrogen cyanide, ammonia or nitric oxide it may be necessary to increase the rates of flow of the caustic soda, permanganate and Griess solutions, but generally the rates of flow given are satisfactory. The rate of accumulation of sludge depends on a number of conditions such as gas quality, temperature and depth of seal at E, but with well-made spirals, never less than 15 mm. apart, the apparatus will run continuously for periods up to 48 hours without blockage.

The apparatus was devised by W. R. Dudden, M. N. Gladstone, W. J. Gooderham, B.Sc., A.R.C.S., and A. R. Morcom, B.A., D.Sc., in the Fulham Laboratory of the Gas Light and Coke Company.

CHANGING INFLUENCES in Gas Manufacture

Communication No. 155

by
E. G. STEWART
(Assistant Chief Engineer, Gas Light and Coke Company)

At the present time the Gas Industry probably fulfils all that Parliament envisaged when the Gas Regulation Act was passed in 1920. The cost of gas making has been reduced, albeit the cost of selling has increased, statutory requirements have been met even during strikes in the coal industry, the efficiency of gas manufacture has risen, the sale of gas has been extended, consumer satisfaction has increased and greater efficiency in the use of gas has been secured.

Manufacture.

It would not be correct, however, to credit these successes entirely to the passage of the Act. In the succeeding years, as is well known, the whole process of gas manufacture and purification has been the subject of close investigation and much research. The simultaneous production of water gas and coal gas by steaming the charge has been brought to a fine art. The water gas process has been improved and automatic control made available. In both coal and water gas manufacture, means have been generally adopted to recover heat previously wasted after heating the retorts or in the coke charge, so raising the thermal efficiency of gas production.

Purification.

The recovery of tar, ammonia and hydrogen sulphide have all responded to examination of their respective means of extraction.

Other processes, too, have been added to the classic purification methods. Ever since the commencement of the Gas Industry the necessity of maintaining continuity of supply has been one of the first things taught the gas engineer learning his craft. For very many years this virtue remained hidden, but the coming of publicity has recently seen it placarded in the slogan "Gas never lets you down."

Removal of Naphthalene and Water.

The focussing of scientific knowledge and ability on refinements to this end resulted in the introduction of processes for the removal of those two bugbears, naphthalene and water, whose deposition in the canalization system anywhere between the Works and the burner injector will cause impairment, if not cessation, of the flow of gas, and consequently detract from service to the consumer. Simple washing of the gas, with oil for the former and calcium chloride or glycerine for the latter, gives the desired result, and many Undertakings have adopted both processes.

Unfortunately, the success obtained has not been entirely straightforward. The removal of naphthalene has shown that its presence in the water of gasholder tanks acted as a bactericide. Consequent upon its removal the bacterial production of hydrogen sulphide in gasholders appeared. Chemical investigation has found means of dealing with this visitation by the addition of zinc compounds and similar substances.

The presence of water vapour, leading as it does to blockages of mains and services by liquid or frozen water, to continual expense of syphon pumping, to rust deposits and damage to meters, can be eliminated and the attendant disadvantages removed at a cost negligible in comparison with the saving of expense in dealing with complaints, meter repairs, &c.

At present, of the 340,000 mill. cu.ft. made annually by the Gas Industry, the quantity treated for dehydration is approximately 110,000 mill. cu.ft., or one-third.

Removal of Gum and Reduction in Gum Formation.

As with naphthalene removal, so with water vapour. In a number of Works the application of gas dehydration has been succeeded by trouble from the deposition of small quantities of resinous gums in the smaller apertures of governors and appliances. It may be that the fear of exchanging a known trouble for this unknown one has hindered the more general adoption of gas drying. Research work has shown, however, that the gum trouble is no new one, but had either previously been concealed in the deposits of naphthalene, or alternatively that the gum had been formed and deposited in the moist atmosphere of the gasholder during storage, provided sufficient time had elapsed for the reaction and settlement to take place.

Research has also shown that care in the carbonizing process can appreciably reduce the nitric oxide responsible for gum formation by combination with certain active hydrocarbons, so that potential gum formation can be reduced, whilst the subsequent storage of gas for several hours in a moist atmosphere will bring about the desired deposition of any gum that can be formed. The proper place of the dehydrating plant is therefore at the outlet of gasholders. The usual position of existing plants is unfortunately on the inlet of holders, a position selected so that the capacity of the washer need only be that of the make, and not that of the peak demand. The necessary alterations, however, may not be more than the cost of transfer of connections as calcium chloride plants at least have been found to possess a high overload capacity. It is possible, however, that pressure loss will be an important consideration in some Works, and then additional gas pumps will be needed. Alternatively, the plant may be located on the outlet of one or more holders arranged to store the gas in a moist condition, and the dried gas boosted into dry holders (oil filmed or waterless) for distribution. Meanwhile, efforts have not slackened in the direction of removing gum by other means, such as the employment of catalytic processes. Gum formation has come to the fore as a result of naphthalene and moisture removal, but neither had any part in its cause.

Benzole Recovery.

Benzole recovery is not, of course, a process for improving gas. Its value is mainly economic, depending on the relative value of certain hydrocarbons as gas or as motor spirit. Nevertheless, the processes adopted have simplified naphthalene extraction, and in some cases have brought about the partial removal of the organic sulphur compounds, so that the process can be and is being used for the improvement of gas quality, which is then effected at no cost.

Reduction of Sulphur Compounds.

This matter of sulphur compounds was brought before the Institution last year by the Research Executive Committee, and the slogan "Sulphur must go" was favourably approved. Extensions to manufacturing plants of processes for the reduction of sulphur have, however, been slow. The catalytic processes, the removal with benzole by active carbon, and more recently the modified benzole oil washing process of the Gas Light and Coke Company, are all in successful operation, as proved and tried processes, as has been mentioned. In fact some 25,000 mill. cu.ft. of coal gas are now so treated annually in London, and further installations are being planned.

Examination of successive annual Returns of the Board of Trade will provide evidence, if any were needed, of the steady increase in efficiency of gas production, and throughout the greater number of Gas Works in the country it is probable that manufacture is approaching a maximum of commercial efficiency.

It is somewhat disturbing, then, to find that the adoption of processes of tried and proved value such as dehydration and the reduction of sulphur compounds, or the generally profitable recovery of benzole are by no means general. Only one-third of the total gas made is treated for dehydration or benzole recovery, whilst sulphur removal processes are applied to less than 10 per cent. of the total. In passing it may be mentioned that the sulphur reduction process of the South Metropolitan Gas Company has now been in operation for 25 years.

THE DECLARED CALORIFIC VALUE.

For seventeen years the Gas Industry has been free to select the one legal standard of gas quality to suit the types of manufacturing plant installed, the capacities of the storage and distribution systems, to proportion the sales of gas and coke to suit the demands of their respective markets and, of course, to produce gas at the lowest cost.

To date some 844 Undertakings have made declarations and of these 183 have altered their original selection. The

range over the British Isles now stands as from 200 B.Th.U. at Nuneaton to 600 B.Th.U. and, in all, 28 different values have been selected. Table 1 shows the allocation of calorific value in 1924 as shown by Sir J. Ferguson Bell in his Presidential Address to this Institution compared with the situation in 1936, when the number of Undertakings declaring had increased by 50 per cent. These figures show how very closely the Gas Industry has

TABLE 1.—*Comparison of Allocation of Calorific Values in* 1924 *and* 1936.

Declared Calorific Value, B.Th.U. per Cu.Ft.	1924.		1936.		Additions, 1924–1936.
	No. of Undertakings.	Percentage of Undertakings Declaring.	No. of Undertakings.	Percentage of Undertakings Declaring.	
1	2	3	4	5	6
200	..	..	1	0·1	1
270–380	4	0·7	5	0·6	1
400–440	66	11·7	103	12·2	37
450	135	23·9	203	24·1	68
460–470	55	9·7	76	9·0	21
475	60	10·6	93	11·0	33
480–490	45	8·0	41	4·8	− 4
500	172	30·5	292	34·6	120
510–600	28	4·9	30	3·6	2
	565	100·0	844	100·0	279

continued to adhere to the experience gained before 1924 in selecting subsequent values, and also the preference for 500, 450 and 475 B.Th.U., in that order.

In Table 2 the matter has been taken a stage further and the aggregate amounts of gas sold of each calorific value are tabulated.

At the highest values the selection of 560 B.Th.U. by the South Metropolitan Gas Company and the South Suburban Gas Company is noted. Other than these two Undertakings less than 1·1 per cent. of total gas sales is above 500 B.Th.U. The value of 500 is a popular choice,

TABLE 2.—*Analysis of Calorific Values Declared by Gas Undertakings in British Isles* (1936).

Declared C.V. B.Th.U. per Cu.Ft.	No. of Undertakings.	Mill. Cu.Ft. Gas Sold per Annum.	Percentage of Total Sales.
1	2	3	4
200	1	181	0·06
320	1	18	..
350	1	17	..
375	2	105	0·03
380	1	88	0·03
400	21	2,201	0·70
410	4	1,244	0·39
415	1	8	..
420	10	1,572	0·50
425	38	4,161	1·32
430	18	2,410	0·76
435	1	15	..
440	10	1,774	0·56
450	203	57,178	18·11
460	33	10,364	3·28
465	3	1,091	0·35
470	40	25,969	8·23
475	93	47,523	15·05
480	38	14,027	4·41
490	3	1,415	0·45
500	292	122,802	38·91
510	2	439	0·14
520	2	87	0·03
525	7	1,059	0·34
540	2	404	0·13
550	9	116	0·04
560	3	19,285	6·11
600	5	113	0·04
..	844	315,666	100·00

covering 38·91 per cent. of sales. Next comes the range 470–480 with 27·72 per cent., and then 450–460 with 21·39 per cent. Below 450 only comprises 4·35 per cent. of sales. By far the greater portion of gas sold by the Gas Industry is therefore between 450 and 500 B.Th.U. per cu.ft.

Considerations of consumer reaction, accountancy, relations with local Authorities, &c., have perhaps prevented further changes. It is probably true, too, that few gas engineers have been entirely satisfied with a selected value at all times over any extended period. Changes in coal, oil and coke prices, the introduction of profitable benzole extraction, peak overloading of small mains, and the installation of modern plant are all factors which lead the engineer at one time to wish for a higher value and at another for a lower one. For these reasons a choice which will be a good average over a long period is the most satisfactory that can ever be realized.

The maker of appliances has at present to cater for a number of calorific values and accordingly provides gas and air adjustments to cover wide ranges. Such adjustments are capable of abuse as well as use. Closer definition of calorific values would make for more simple burners and should cheapen production. It would not seem out of place therefore to expect that in the near future unlimited choice in calorific values will give place to a few standardized values throughout the country, such as 350, 450, 475, 500 and 540. These five would be suitable for any combinations of existing or contemplated means of gas production, whilst the middle three alone should be acceptable to makers of 90 per cent. of the total gas sold, which suggests an even further reduction.

COMBUSTION CHARACTERISTICS.

For the first century of the existence of the Gas Industry the gas engineer was concerned with the production and distribution of gas of good quality. He was aware that properly used it would give to the consumer a specified service, but no great effort was made to this end. For the past generation the idea of consumer service to help the user to obtain the best from his appliances has extended, till to-day it has become a recognized branch of the Industry's activities. With increasing scientific design and production of appliances a new phase is being entered, in which desirable and undesirable properties of gas are being indicated and a call is being made on the manufacturer to bring his product into line in order that the gas user may obtain the highest order of service.

One essential characteristic—calorific value—is already locally standardized, but performance is also affected by specific gravity and composition, which are allowed to change from time to time to suit the convenience of the gas manufacturer.

SPECIFIC GRAVITY.

Figure 1 brings together in diagram form the various factors influencing a bunsen burner. The importance of specific gravity is clearly seen. This property in town gas mixtures is in the main dependent upon the following factors:

(1) The percentage admixture with coal gas of carburetted water gas, blue water gas, producer gas or waste gas.
(2) The quantity of oil used for carburetting.
(3) The quantity of benzole extracted.
(4) The inert content of the gas.

The gravity of coal gas alone is approximately 0·4-0·45. Extraction of benzole will reduce this by 0·03, *i.e.*, to 0·37-0·42. Blue water gas has a gravity of 0·55 which carburetting can raise to 0·68. Producer gas and waste gas will be used as diluents in small percentages only, but each has a gravity in excess of 0·9.

The likely range of gravities, where benzole extraction is practised and/or water gas is used for load balancing and quality regulation, is therefore subject to considerable variation unless a definite effort is made to control it. Several Gas Undertakings have attempted this, and have found that without material disturbance of works operations, limits of say 0·40-0·50 can be maintained, but any narrowing becomes increasingly difficult.

TEST BURNERS.

In so far as calorific value and specific gravity are concerned, the properties of any mixture of gases can be arithmetically calculated from knowledge of the various constituents. This is not, however, the case with regard to the burning properties of any gas mixture which are dependent on the relation between the flame velocity of the gas, the air-gas ratio and the velocity of the air-gas mixture. The appliance designer having settled the ratio of primary and secondary air to secure proper combustion at normal and overload ratings, having regard to the nature of the gas, is then faced with securing a defined shape and size of flame. In practice the height of the inner cone, which is a measure of flame propagation, is found to be the controlling factor. If this is or becomes too long, giving a soft flame, combustion may be impaired, unwanted flame contacts may occur and efficiency be lowered. Alternatively, too short a cone giving a hard flame will lead to noisy operation, risk of flashing back or blowing out and irregular control.

In recent years in Germany, Switzerland, the U.S.A. and this country, including present work at Leeds University on behalf of The Institution of Gas Engineers,

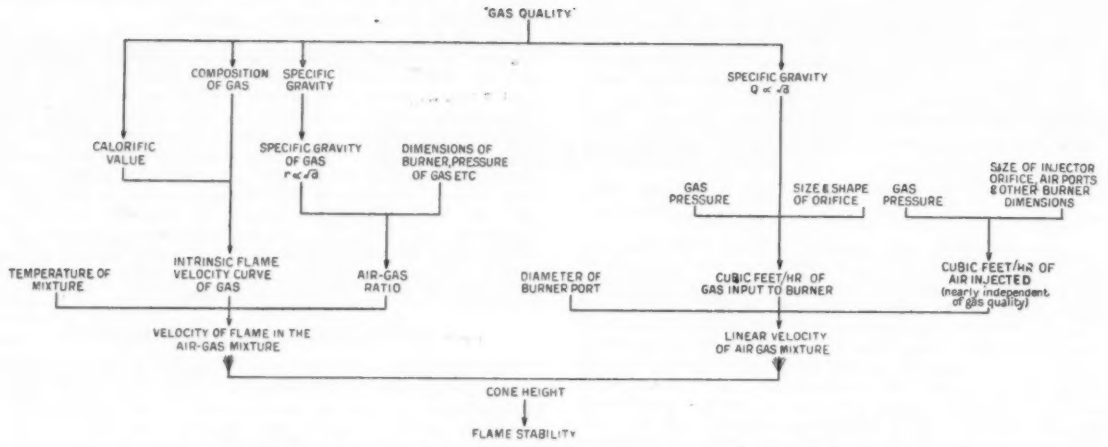

"GAS QUALITY"
COMPOSITION OF GAS
SPECIFIC GRAVITY
SPECIFIC GRAVITY Q ∝ √a
CALORIFIC VALUE
SPECIFIC GRAVITY OF GAS r ∝ √a
DIMENSIONS OF BURNER, PRESSURE OF GAS ETC
GAS PRESSURE
SIZE & SHAPE OF ORIFICE
GAS PRESSURE
SIZE OF INJECTOR ORIFICE, AIR PORTS & OTHER BURNER DIMENSIONS
TEMPERATURE OF MIXTURE
INTRINSIC FLAME VELOCITY CURVE OF GAS
AIR-GAS RATIO
DIAMETER OF BURNER PORT
CUBIC FEET/HR OF GAS INPUT TO BURNER
CUBIC FEET/HR OF AIR INJECTED (nearly independent of gas quality)
VELOCITY OF FLAME IN THE AIR-GAS MIXTURE
LINEAR VELOCITY OF AIR GAS MIXTURE
CONE HEIGHT
FLAME STABILITY

FIGURE 1.—*Factors Influencing Combustion in a Bunsen Burner.*

efforts have been made to devise means of assessing these combustion characteristics.

Aeration Test Burner.

In this country a simplified burner based on the same principles as the "Prüfbrenner"* but of British design, called the Aeration Test Burner has recently been produced by Alexander Wright and Company. Results from this apparatus, known as "A.T.B. Numbers," will be referred to later. Of the various instruments proposed the "Prüfbrenner" and the Aeration Test Burner (A.T.B.) would appear to give most satisfactory and reproducible results. Both, however, are of comparatively recent development, and insufficient tests correlated with gas composition, calorific value and specific gravity have been carried out from which reliable deductions can be made of the effect of changes in gas composition. As yardsticks, therefore, the various "numbers" must be empirical at present.

In Table 3 are shown 7 analyses of gas together with their associated calorific values, specific gravities, and A.T.B. numbers. Particular attention is drawn to columns 4, 5, 6 and 7 as illustrating the variations possible with gas of a constant calorific value of 500 B.Th.U.

To-day branches of the Gas Industry in a number of countries concerned with the development of appliances are suggesting in their efforts to secure the highest standards of performance, that the properties of gas need definition. Further, they have by research approached very nearly towards gaining ability to specify these characteristics. This ability may be positive, such as the limitation of variation of calorific power, specific gravity, content of inerts or carbon monoxide, or empirical, as would be the specification of desirable properties by test burner numbers.

In common with other progressive industries, the gas appliance manufacturer of to-day has in general adopted the modern methods of scientific design, mass production and national advertisement. In so far as gas consumers in various parts of the country secure from any such design of gas-using apparatus the performance intended by the manufacturer, consumer satisfaction and recommendation will help to swell its sales and extend its use. On the other hand, reports of faulty operation from a particular district, which might arise because of the unsuitability for the appliance in question of the characteristics of the gas distributed there, will lead to the opposite result and may damage the reputation of that appliance in the areas of other Undertakings where the disability is, in fact, non-existent.

The proper selection of gas-using apparatus, and the maintenance of the intended standards of performance of such apparatus, thus becomes a responsibility of each individual Gas Undertaking, in order that the reputation of the Gas Industry and its service shall be maintained. It is a matter of concern to every gas engineer, therefore, that the gas manufactured under his direction should be of such a nature as will at all times meet those reasonable requirements which may be generally demanded as a result of progress in gas utilization technique.

Unfortunately, the correlation of some of these requirements with the properties of gas produced by various methods has not been so closely investigated as yet, and accordingly the gas engineer can only view the subject broadly and meanwhile examine his methods with a view to possible modifications in the future.

FLEXIBILITY OF GAS MANUFACTURE.

With suitable combinations of manufacturing plant the present processes enable the engineer to meet wide variations in regard to coal and coke conditions. By the use of the following formulæ calculated on the same basis as those used to obtain his Hydrocarbon Enrichment Value,* S.

* Designed by Czakó and Schaak.

* Gas J., 1934, **208**, p. 733; J.Inst.Fuel, 1935, **8**, p. 200, *et. seq.*

TABLE 3.—*Composition and Properties of Town Gases of Different Origin.*

—	Straight Coal Gas from Horizontal Retorts, not Debenzolized.	As Col. 2 Debenzolized.	Gas from Steamed Vertical Retorts, not Debenzolized.	Mixture of Debenzolized Straight Coal Gas and B.W.G.	Mixture of Debenzolized Straight Coal Gas (¾) and C.W.G. (¼).	Carburetted Water Gas.	Blue Water Gas.
1	2	3	4	5	6	7	8
CO_2	2·0	2·0	2·2	2·2	2·9	4·3	4·1
O_2	0·5	0·5	0·5	0·5	0·5	0·5	0·5
C_nH_m	3·4	2·5	2·4	2·3	3·8	6·7	
CO	6·9	7·0	10·0	10·0	17·8	33·5	37·2
CH_4	28·7	29·0	23·6	26·1	21·6	12·5	0·3
H_2	52·0	52·5	54·8	52·3	46·3	34·5	50·9
N_2	6·5	6·5	6·5	6·6	7·1	8·0	7·0
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0
C.V. (gross), B.Th.U. per cu.ft.	554·0	524·0	500·0	500·0	500·0	500·0	283·0
Sp.Gr.	0·420	0·400	0·399	0·415	0·499	0·668	0·540
Characteristic of flame— A.T.B. number (approximate)	(250) off scale	140	85	85	60	50	10

Pexton, of the Gas Light and Coke Company, has devised a very neat form of diagram to indicate the collateral effects of variations in admixture of water gas, variation in benzole extraction, &c.:

Where C = tons of coal carbonized per 5,000 therms of town gas.
G = gal. of oil used per 5,000 therms of town gas.
N = gal. of benzole extracted per 5,000 therms of town gas.
11 = assumed percentage of inerts in the town gas.
35 = hydrocarbon enrichment value per ton of coal carbonized.
500 = calorific value of the town gas.
1·1 = hydrocarbon enrichment value of carburetted water gas per gal. of oil.
1·4 = hydrocarbon enrichment value of a gal. of benzole.

(*a*) *Coal-Oil Relationship.*

$$35C + 1{\cdot}1G - 1{\cdot}4NC = \frac{5{,}000}{500}\left[500 - 318\left(1 - \frac{11}{100}\right)\right] = 2{,}170 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

(*b*) *Coke-Oil Relationship.*

If 0·564 = tons of coke and breeze per ton of coal after providing producer fuel, and the coke to manufacture the blue water gas necessary to dilute the straight coal gas to the calorific value of the town gas.
0·008 = tons of coke used per gal. of gas oil to manufacture carburetted water gas of 500 B.Th.U., and
0·113 = tons of coke which would be used to make the blue water gas necessary to dilute a gal. of benzole as vapour to the calorific value of the town gas,
K = tons coke plus breeze per mill. cu.ft.

$$K = 0{\cdot}564C - 0{\cdot}008G + 0{\cdot}113NC \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

(*c*) *Coal-Oil Relationship Based on* (1).

This becomes:
35C + 1·1G = 2,170 when no benzole extracted.
30·8C + 1·1G = 2,170 for 3 gal. ,, ,,

(*d*) *Coke-Oil Relationship Based on* (2).

This becomes:
K = 0·564C − 0·008G when no benzole extracted.
K = 0·598C − 0·008G for 3 gal. ,, ,,

(*e*) *Specific Gravity-Oil Relationships.*

S.G. = 0·447 + 0·000113G when no benzole extracted.
S.G. = 0·415 + 0·000124G for 3 gal. ,, ,,

These figures are for a gas of 500 B.Th.U. and the results are plotted in Figure 2. A like diagram could be produced for any calorific value or other conditions by similar methods, which are explained fully in the above-mentioned Paper to the Institute of Fuel.

It will be seen that for the production of one million cu.ft. of mixed gas the raw materials required can vary between 71 tons of coal and 47 tons of coal with 500 gallons of oil. The quantity of coke produced would range between 42·5 tons and 22 tons. At the same time, the range of specific gravity would be from 0·42-0·50 (0·08 points). The Aeration Test Burner numbers would probably range between 60 and 90 (30 points).

Standards recommended by the German Association of Gas and Water Engineers require that the specific gravity of gas in Germany shall not exceed 0·5, and that any variation should be limited to an absolute value of 0·012. No regulation by burner numbers has as yet been suggested. It is also recommended that the gross calorific value divided by the specific gravity should not vary more than ± 1·5 per cent. A recent proposal for an improvement of this function which regulates the heat input of an appliance is the "Wobbe Index"

$$= \frac{\text{C.V.}}{\sqrt{\text{Sp. Gr.}}}.$$

Preliminary work in England with the Aeration Test Burner indicates that variations in excess of 14 numbers, or say 18 points on the Ott Burner at the appropriate part of the scale, or of variations in specific gravity in excess of ± 0·025, can give rise to poor results from certain modern types of gas apparatus.

In the absence of compensating factors, the nature of which is at present vague, any proposals for limiting specific gravity or for standardizing combustion characteristics, will tend to reduce the flexibility of gas production which is enjoyed to-day.

Other than the gasification of oil, all changes in the calorific value, specific gravity, combustion characteristics and CO content of gas are principally due to the admixture with straight coal gas of gas derived from coke. Hence any limitation of these properties defines the proportion of coke gas to coal gas, limits variation in the use of coke gas and affects the production of coke for sale to the public. Furthermore, if the proportion of coke gas is to be fixed, it follows that stability in the demand for coke over a long period must be secured.

THE MARKET FOR COKE.

It seems pertinent then to examine the coke market and its probable future. The domestic and small industrial coke market is no longer, as it once was, the exclusive domain of the Gas Industry. During the past years of depression in the iron and steel industry, notably in 1931-1933, oven coke producers entered this market, and having found a profitable outlet for surplus coke are not likely to relinquish it in the future. The quantity of oven coke competing with gas coke increased from half a million tons in 1917 to approximately 3¼ million tons in 1934 and 1935. Last year the figure fell to nearly 2 million tons, but this can only be regarded as a temporary phase due to trade revival. The consumption of coke in the manufacture of iron and steel in 1913 reached 12 million tons per annum, but in the absence of unusual conditions, the iron and

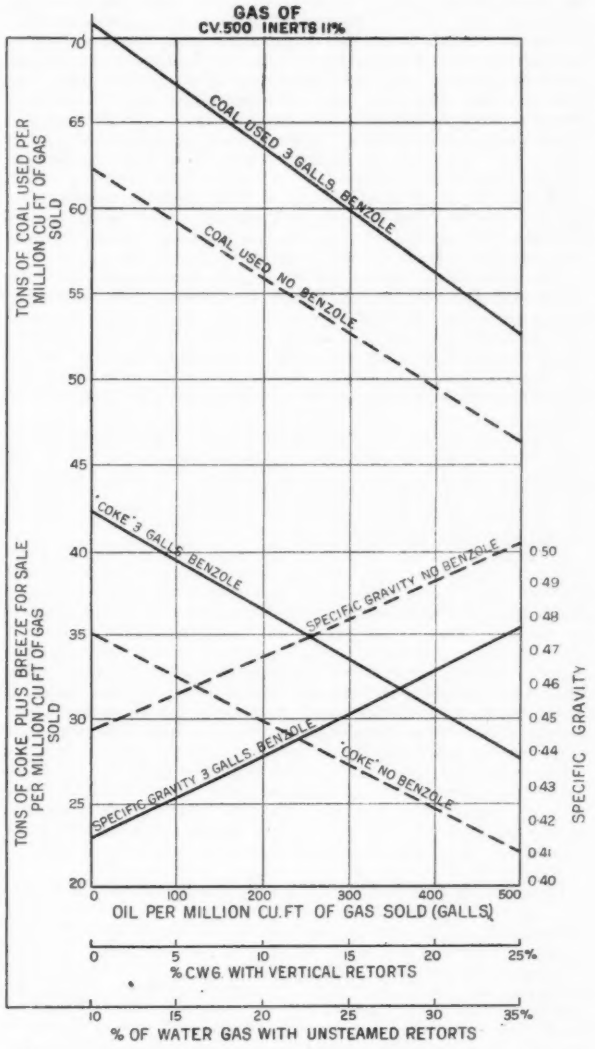

GAS OF
CV.500 INERTS 11%
TONS OF COAL USED PER MILLION CU FT OF GAS SOLD
COAL USED 3 GALLS BENZOLE
COAL USED NO BENZOLE
TONS OF COKE PLUS BREEZE FOR SALE PER MILLION CU FT OF GAS SOLD
COKE 3 GALLS BENZOLE
SPECIFIC GRAVITY NO BENZOLE
SPECIFIC GRAVITY 3 GALLS BENZOLE
COKE NO BENZOLE
SPECIFIC GRAVITY
OIL PER MILLION CU.FT OF GAS SOLD (GALLS)
% CWG WITH VERTICAL RETORTS
% OF WATER GAS WITH UNSTEAMED RETORTS

FIGURE 2.—*Effects of Variations in Admixture of Water Gas, in Benzole Extraction, &c.*

steel industry is unlikely to absorb so much in future, because of:

(*a*) Increased scrap used in steel manufacture.
(*b*) Smaller production of wrought iron.
(*c*) Decline of export trade in pig iron.
(*d*) Improvements in blast furnace practice.

In the past few years the modernization of oven plant has proceeded apace, old ovens have been replaced (1934-36) by ovens of approximately 12,595 tons coal capacity per day, and additional ovens of a capacity of 8,250 tons of coal per day installed. In the design of these ovens the domestic market has been borne in mind, so that there is the possibility in the future of an additional 2 million tons of coke annually entering and competing with gas coke markets, particularly in markets for the associated gas are found. The position may become embarrassing in three or four years' time unless producers of all types of coke co-operate for the purpose of arranging output and controlling prices. The London and Counties Coke Association has operated successfully on these lines since 1931, and now handles annually some 3 million tons of coke or 30 per cent. of the total gas coke trade of the country. More recently the North East Coast Producers

Association with similar objects has come into satisfactory operation. Similar associations are contemplated with centres at Birmingham, Manchester and elsewhere, and it is highly desirable that the efforts of these bodies should ultimately be linked by a national co-ordinating association.

Such associations are doing excellent work in opening up new markets, improving the revenue from coke and thus cheapening gas production, as well as stabilizing coke demand both in quantity and quality. More than ever before it is becoming incumbent upon the gas producer to encourage such movements. Much work has been done by them in the development of new coke burning appliances, such as the thermostatically controlled gravity fed central heating boiler, the proper design and specification of the small domestic hot water boiler and, perhaps more important still, the development of proper open fire coke grates. Each of these developments has initiated a demand for a prepared coke, and in every case these cokes have commanded higher prices than had hitherto been obtained. Care must be exercised that the number of grades does not become too extended and, further, that enthusiasm to produce fuels of the highest quality, or special purpose fuels, does not involve such heavy costs for cleaning, grading, washing, or cutting losses, as will wipe out the benefit of the extra price obtained.

The domestic boiler and the open fire grate are pre-eminently suitable for prepared gas coke. The former is being installed over the country at the present rate of over 150,000 per annum, the latter at a rate of over 70,000 per annum. The coke consumption of the domestic boiler averages 2 tons per annum, whilst each coke open fire grate consumes annually 1½-2 tons of coke, and 15-20 therms of gas.

The small industrial market too is a valuable and growing load which is worthy of cultivation because of its steady demand and cheaper deliveries. Finally, there are the recently developed horticultural uses for coke which reach their peak when domestic trade is slackest, and so reduce stacking losses in summer.

Central heating, horticulture and agriculture (grass drying), however, are all markets easily suited to the denser varieties of coke, whereas gas coke, whilst always available for these uses, is pre-eminently suited to domestic needs. This overlapping of suitability of dense and light cokes postulates unified regulation of both of the coke producing industries in these fields to stabilize markets and prevent cut-throat competition in the face of those real competitors, coal and oil. Such co-operation would strengthen the export position and international negotiations affecting it.

Summing up, it may be said that the outlook for coke indicates a growing and remunerative market which can, with care and planning, be kept free from the fluctuations of the past in spite of increasing penetration of the markets of the Gas Industry by oven coke, and the competition of coal and oil.

In so far as this can be achieved, the flexibility in variation of water gas production previously needed to meet these fluctuations can be limited, whilst the higher the net return received for coke, the less is the necessity of converting some portion of the yield to gas. In addition the tendency of the Industry to break away from its established methods is lessened. Acceptance of a limited flexibility, however, entails a limitation of power to avoid low prices or to take advantage of high prices in the coke market.

PEAK LOADS.

The problem of meeting peak loads is not so directly solved. The short period peak due, for example, to the Sunday dinner load, or the more extended one arising from different habits of consumers on individual days, can always be overcome by the installation of adequate gas storage. If changes in the character of the gas sent out are to be avoided, this method must become standard, and the irregular addition of water gas eschewed.

Reserve Plant.

The larger changes in demand which arise mainly from cold spells, but occasionally at holiday resorts from short period influxes of visitors, are not amenable to this solution. With coal gas plant unaided the necessary flexibility can only be secured by maintaining a surplus of plant under slow fires. With our climate spells of severe weather are of short duration and of sudden onset, so rendering any coal gas plant not actually under fire of little use. As recently as 1935 Dr. A. G. Glasgow lucidly presented to this Institution the advantages of water gas plant in this connection.

In comparing coal gas and water gas units held in reserve for the purpose of meeting changes in demand it will be agreed that in respect of capital, maintenance and operation costs the advantage is always with water gas. It is sometimes held, however, that a good return for coke so decreases the cost of coal gas and increases the cost of water gas as to balance these advantages.

This is not necessarily so, nor is it definite that the use of water gas for the purpose will reduce the coke available for sale, as the following rough calculation will show:

Plant held in reserve . . .	Say, 100,000 cu.ft. per day capacity.
If coal gas	Carbonizes 7 tons coal per day.
	Coke for sale to public, 3¼ tons.
	Uses on slow fires 1 ton per day.
If water gas	Uses when working 1¾ tons of coke daily.
	When standing—no coke.

Thus if the coal gas unit stands on slow fires 5 days for each day of useful work, the net consumption of coke will be 1¾ tons, which is equal to that of the water gas plant under similar conditions, and the advantage of water gas increases as the proportion of stand-by days to working days exceeds five to one.

Plant held in reserve for these occasional peaks ought to be low in capital cost, cheap to maintain, and immune from serious damage due to frequent putting in and out of action. Operating costs and thermal efficiency are secondary considerations in view of the small amount of work performed.

The hand operated water gas plant with waste heat boiler has therefore much in its favour. The intermittent use of water gas is nevertheless disturbing to gas characteristics, and some means of balancing, such as partial carbon monoxide extraction or changes in benzole recovery, must be sought.

It is likely too that the Gas Industry will find, as does the electrical industry to-day, the desirability of cultivating new loads which will balance the peak demands of existing loads.

Interconnection of Adjacent Undertakings.

Consideration should also be given to the possibility of linking up adjacent Gas Undertakings so as to take advantage of diversity in loads. Although, as the reports of the several Area Gas Supply Committees have shown, there is no general case for gas grids because there is not the economy in concentration of manufacture in large units as is the case with electricity, and coal transport is normally cheaper than the combined cost of coke and gas transport, there would appear to be some justification for smaller connections. Not only would they help at times of peak load, but would save further capital being sunk in stand-by plant. For example, the surplus plant capacity of the Gas Light and Coke Company, with a system of trunk mains coupling all its Works, needs to be no more than 15 per cent. over the maximum day's demand, whereas 20 separated Undertakings of the South Eastern Gas Corporation have an aggregate manufacturing capacity of nearly 50 per cent. in excess of the aggregate maximum day.

These connections might be small mains operating at pressures of say 50 lb. per sq.in., and in passing the fringes of the districts could give supplies otherwise costly and uneconomic.

The objection, in view of quality strictures, to such a procedure is the likelihood of gas from different types of plant from the connected Works alternating on the district each with its own combustion characteristics.

COMPLETE GASIFFICATION.

Some mention should be made of the process of complete gasification. At present no process of general acceptance is available. Such as do exist would entail large increases in the capacity of holder storage and distribution systems, even if they could produce gas on Works at competitive prices. The effect too of the withdrawal of the Gas Industry from the coke market, even locally, to any extent, is not easily predicted but would certainly not help the progress of the new departure. Further, the high carbon monoxide content of the gas produced would be a disadvantage. The work of the Joint Research Committee in investigating the oxygen and high pressure process is to be commended, and it may be that ultimately the future will be concerned with some such process, which would produce gas similar in composition to that from present processes.

Meanwhile indications of the early demise of present-day practice are lacking, even apart from the capital sunk in it.

CONCLUSION.

Over a long period of time the manufacture of gas has been directed to secure continuity of supply, freedom from hydrogen sulphide, and compliance with a statutory standard. Working to this specification, considerable technical progress has been made, and the cost of production reduced. In recent years the concept of service to the consumer has resulted in increasing effort being made to

secure to the public high efficiency in use of both gas and coke produced. The Gas Industry has itself become interested in the design and specification of performance of appliances to this end.

In gas appliances guaranteed, reliable and efficient performance coupled with perfect combustion and minimum maintenance has been the ideal. The flueless use of gas for space heating has also been extended.

As a contribution to this end additional works plant for the removal of naphthalene, moisture, gum, &c., has been installed, and there has been an extension of a pioneer movement for sulphur removal. But these additions, though widespread, are not yet general, and the overall as distinct from the localized efficiency of the Industry in regard to these refinements has been queried.

Specialization has resulted in work at home and abroad being undertaken on the desirable characteristics of gas to secure the highest performance standards in gas usage. Present results show that such work is likely to require additional standards of gas quality in future, including the limitation of specific gravity variation and the setting up of combustion characteristic standards.

Such proposals will tend to reduce the present flexibility of gas manufacture, but will not invalidate present processes if the market for coke can be profitable and at the same time more stable. Recent progress by planned effort shows every indication of achieving this state of affairs. Difficulties may still arise in dealing with peak loads, and for reserve plant water gas has many advantages but means of avoiding disturbance to the characteristics of gas must be found, whilst the advantage of small connections between adjacent Gas Undertakings is proposed.

Taking a broad view it would appear that the business of gas making is likely to become more complex in future. Demands will be made for the services of chemists and physicists, as well as engineers. In fact, manufacturing policy, as well as the design, installation and operation of Gas Works plant in the future will necessitate the closest collaboration at all stages between engineer, chemist and perhaps other trained scientific workers. It is likely that the smaller Undertakings will be unable to afford individually such a wide range of trained scientific talent, and will be compelled to join collectively with others to secure pooled services from corps of specialists. Such groups might well be incorporated with the grouping of Gas Undertakings for commercial purposes, now so much in evidence.

Co-ordinated policy is the theme of the age, and every day sees a consolidation of the aims of our competitors—electricity, oil, oven coke and even coal. The Gas Industry has been built upon a foundation of individualism supported by a free interchange of experience. Co-operative effort has gradually been interwoven into the structure, but even to-day progress is not necessarily uniform. With parallel development in manufacture and utilization coupled with the mass production and national advertisement of appliances, it is essential that the closest interest and collaboration should be maintained by each in the other's activities. At all times the consumer should have available the best that progress can afford; but in so doing no step must be taken, no demand made, which will stultify manufacturing progress or limit more than necessary the flexibility of process to meet changes in coal, oil or coke markets, or scientific advance.

The marked progress in gas using appliances in recent years is common knowledge. If the maximum advantage is to be secured from these developments the manufacturing side of the Gas Industry must be prepared to view critically all new designs of gas using apparatus with the object of eliminating any which require an undue limitation of gas properties, but at the same time to:

(1) Expedite research into the properties of gas mixtures from existing and likely combinations of gas manufacturing plant, so as to relate them to changes in combustion characteristics. This would place the Gas Industry in a position to recommend standard gas properties and tolerances as and when needed.

(2) Examine the effect of the various constituents of town gas mixtures upon the resulting combustion characteristics, with special attention to methane, carbon monoxide, inerts and benzole extraction, in order that such balancing factors as may exist can be discovered and utilized so as to maintain the maximum freedom of manufacturing processes whilst laying the foundations of future progress.

(3) In the meanwhile, limit as far as possible changes in the composition and other properties of gas sent out and, where such changes are unavoidable, give due consideration to the likely effects on consumers' apparatus.

(4) Extend the benefits of dehydration, denaphthalenation, and reduction of sulphur compounds to as many consumers as possible.

The weakest link settles the strength of the chain. Future work must be planned so that weakness does not arise either by manufacture or utilization cramping the development of the other, or by portions of the Gas Industry lacking the progress of the remainder.

Distribution of Gas in SUBURBAN AND RURAL AREAS

Communication No. 156

by
H. J. ESCREET
(Distributing Engineer, Gas Light and Coke Company)

ANNUAL COSTS OF SUPPLYING NEW CONSUMERS.

The first matter to be decided when considering the supply of new houses, new estates and parts of the district not already supplied is the probable revenue to be obtained and the capital expenditure necessary to give the supply.

Normally, the cost of carcassing the houses, supplying apparatus, &c., will be borne by the consumer or, in the case of automatic supplies, will be provided for by the additional charge made for gas supplied through an automatic meter. The cost of the main is, therefore, the determining factor in deciding whether a supply can be given economically.

There are various ways of assessing the value of a proposed extension of main, but the method adopted by the Gas Light and Coke Company may be of interest to those who are not already familiar with it.

The capital cost of the required main is estimated and it is assumed that an annual charge of 8 per cent. upon this capital must be met by the profit from the gas consumed per annum in the houses to be supplied.

The 8 per cent. upon capital expenditure is reduced to pence and divided by the total estimated consumption in therms. This gives the annual charge in pence per therm for the proposal, and this figure is used as the criterion of the economic value of the extension.

As an example, if the cost of a proposed main is £X and Y consumers are to be supplied from the main, each with an annual consumption of Z therms:

The annual charge for the main

$$= X \times \frac{8}{100} \times 240 \text{ pence.}$$

The estimated annual consumption

$$= Y \times Z \text{ therms,}$$

and the annual charge per therm

$$= \frac{X}{YZ} \times \frac{8}{100} \times 240 = \frac{19{\cdot}2\,X}{YZ} \text{ pence.}$$

When the proposal has been reduced to terms of the annual charge per therm, the next step is to decide what charge can be allowed. In deciding upon the limiting charge it is necessary to take into account future development. The annual charge for existing consumers as calculated from the total gas sold and the capital cost of the whole mains system will probably be found to be relatively low (in the Gas Light and Coke Company it is just below ¾d. per therm) but for new business a considerably higher figure must be allowed if the needs of a developing district are to be met. On the suburban areas of the Gas Light and Coke Company a standard of 2·5 pence per therm is allowed, while on the outer areas, where a differential price is in force, the standard charge is increased accordingly.

The estimate of annual consumption per house must be

based on the previous experience of each Undertaking but the following are representative figures:

Week-end bungalows	50 therms per annum
Cottages in rural areas	75 ,, ,,
Artisan dwellings	100 ,, ,,
Middle-class suburban houses	150 to 200 ,, ,,

For larger houses individual estimates should be made, based on the apparatus likely to be installed and other conditions.

The 8 per cent. charge for mains is made up of:

5 per cent. interest on capital.
2 per cent. for depreciation.
1 per cent. for maintenance.

The interest charge is, perhaps, rather high for the conditions of the past few years, but it is probable that the charge for money will increase with increasing prosperity. 2 per cent. depreciation corresponds to a life of about 30 years, which is a short life for cast iron mains but is the loan period allowed by the Ministry of Health for Local Authority Undertakings, and depreciation and maintenance charges must be considered together. If a longer life were allowed it would be advisable to make a higher allowance for maintenance so that the sum of the two items would probably be about constant.

The criterion of annual charge per therm should not be rigidly applied. If development is likely to be rapid a high first charge may be allowed. as the charge will be reduced after a few years, but the annual charge does give a good basis upon which to make allowances for local circumstances.

A special problem arises when it is proposed to supply a village or other group of houses which are already supplied with electricity and where building development is taking place. Probably the immediate return on the cost of mains will be small as the residents are already using electricity, but if no gas were available every new house would also be fully supplied with electricity and the position would not improve as time passed. If the mains are laid there is good prospect of the new houses being carcassed for and supplied with gas, and the existing residents may be persuaded to adopt gas for various purposes in due course.

Another question to be considered in supplying existing groups of houses is whether the estimated annual consumption should be based on a canvass or on the total number of houses. It is often found that people are unwilling to commit themselves when canvassed and that the ultimate number of consumers after the supply has been available for a year or two is much higher than the canvass indicated. It is probably best to adopt the same method for existing houses as for new estates, *i.e.*, base the estimate on all residents taking a supply but make a conservative estimate of the annual consumption.

Table 1 shows the capital expenditure per annum corresponding to various annual consumptions and annual charges per therm, and Table 2 gives equivalent lengths of 4 in. mains (calculated at 10s. 6d. per yard).

TABLE 1. *Capital Expenditure per Consumer.*

Annual Charge, Pence per Therm.	Annual Consumption (Therms).				
	50.	75.	100.	125	150.
1	2	3	4	5	6
	£ s.	£ s.	£ s.	£ s.	£ s.
1	2 12	3 18	5 4	6 10	7 16
2	5 4	7 16	10 8	13 0	15 12
3	7 16	11 14	15 12	19 11	23 9
4	10 8	15 12	20 17	26 1	31 5

TABLE 2.—*Length of 4 In. Main at 3s. 6d. per Foot.*

Annual Charge, Pence per Therm.	Annual Consumption (Therms).				
	50.	75	100.	125.	150.
1	2	3	4	5	6
	Ft.	Ft.	Ft.	Ft.	Ft.
1	15	22	30	37	45
2	30	45	59	74	89
3	45	67	89	112	134
4	59	89	119	149	179

The above Table may be taken as showing the frontage of house corresponding to the various annual charges per therm. If one main serves both sides of a street these frontages may be doubled.

COST OF PUMPING GAS.

In the previous Section, the cost of supply has been assumed to depend only on the cost of local mains, but in supplying large districts it is generally found necessary to provide one or more high or medium pressure feeder mains to reinforce the low-pressure supply from the manufacturing stations, and in such cases the cost of these and the cost of pumping the gas must be considered in addition to the annual charge for mains.

The Gas Light and Coke Company has an extensive medium-pressure system of mains which serves both for linking up the manufacturing stations and as a feeder main system for reinforcing the low-pressure mains.

The total length of mains in this system is approximately 160 miles and it extends a distance of 37 miles from east to west, and 13 miles north to south forming, therefore, a very considerable gas grid.

This grid is based on Beckton Gas Works and has been developed from the two 48 in. mains originally laid in 1871 for supplying Beckton gas to the City and West End of London. The whole of the gas manufactured at Beckton is pumped into the grid and is partly distributed through the feeder mains and governors and partly transmitted to other manufacturing stations or to storage stations. In order to obtain flexibility, the majority of the other manufacturing stations are also provided with pumping plant so that surplus make, beyond the requirements of their immediate districts, may be pumped into the grid. It is also necessary to have several stations pumping into the grid at times of maximum demand in order to maintain pressures for the feeder mains and governors.

In addition to the grid system, the Company has an extensive high-pressure system for direct supply to consumers through service governors covering the Grays district—an area of some 180 square miles. This system operates with an initial pressure of 30 to 50 lb. per sq.in. according to requirements.

Later in this Paper the costs of supply on various parts of the Company's area are dealt with, and, in order to make these figures complete, it is necessary to determine the costs of pumping gas into the feeder mains or high-pressure mains system. This information is given below.

Beckton.

The plant at Beckton has a maximum capacity of 7½ mill. cu.ft. per hr.—6 mill. cu.ft. working and 1½ mill. cu.ft. standby—and is suitable for pressures up to 3 lb. per sq.in.

The volume of gas pumped during 1936 was approximately 22,500 mill. cu.ft. The charge for fuel and attendance was £19,100. The capital cost of the pumping plant cannot be given because the plant was originally installed in 1879 and has been frequently modified and added to since that date, but the estimated capital cost at present prices is £50,000. Table 3 shows the cost of pumping per 1,000 cu.ft. and per therm* based on the above figures.

TABLE 3.—*Cost of Pumping at Beckton.*

[Gas pumped: 22,500 mill. cu.ft. per annum.]

—	Per Annum.	Per 1,000 Cu.Ft.	Per Therm.
1	2	3	4
	£	d.	d.
Fuel and labour	19,100	0·20	0·040
Interest, depreciation and maintenance; 15 per cent. on capital cost of £50,000	7,500	0·08	0·016
Total cost	£26,600	0·28	0·056

Grays.

This plant is suitable for a pressure of 50 lb. per sq.in. The total capacity is 200,000 cu.ft. per hr.—150,000 cu.ft. working and 50,000 cu.ft. standby—and the capital cost of the plant including buildings, etc., was approximately £10,000. The cost of fuel and attendance for 1936 was £7,600 and the total volume pumped was 550 mill. cu.ft.

Table 4 shows the cost per 1,000 cu.ft. and per therm.

TABLE 4.—*Cost of Pumping at Grays.*

[Gas pumped: 550 mill. cu.ft. per annum.]

—	Per Annum.	Per 1,000 Cu.Ft.	Per Therm.
1	2	3	4
	£	d.	d.
Fuel and labour	7,600	3·32	0·66
Interest, depreciation and maintenance; 15 per cent. on capital cost of £10,000	1,500	0·65	0·13
Total cost	£9,100	3·97	0·79

* Calorific value, 500 B.Th.U.

Whole Grid System.

The costs for the whole grid system cannot be given accurately because the gas pumped cannot be measured at most of the stations; also much of the gas is pumped several times in the course of its passage from Beckton to Southall and other western parts of the district. The following costs are based on the total costs of pumping and estimates of the volume pumped, and may be taken as approximately correct:

	Cost per 1,000 Cu.Ft.	Cost per Therm.
	d.	d.
Including capital charges	0·37	0·074
Excluding ,, ,, ...	0·23	0·046

It is of interest to compare the costs given above for Beckton and Grays with those calculated from the data given in "Economic Aspects of High-Pressure Distribution"† and Table 5 shows the actual and calculated figures, set out as in the examples in that Paper.

TABLE 5.—*Comparison of Calculated and Actual Figures for Cost of Pumping at Beckton and Grays.*

—	Beckton.		Grays.	
1	2		3	
Rate of gas delivery, cu.ft. per hr.	6,000,000		150,000	
Initial gauge pressure, lb. per sq.in.	3		50	
Horse power per 1,000 cu.ft.	0·4		3·2	
Total horse power . . .	2,400		480	
—	Calculated.	Actual.	Calculated.	Actual.
	£	£	£	£
Capital cost of pumping plant	14,000	50,000	6,000	10,000
Interest, depreciation and maintenance; 15 per cent. on capital cost . .	2,100	7,500	900	1,500
Running costs—				
8,760 hr. (continuous pumping).	43,800*	19,100	8,760*	7,600
3,750 hr. (*a*)	18,750*			
3,660 ,, (*b*)			3,660*	
Total annual pumping costs—				
Continuous pumping . .	45,900	26,600	9,660	9,100
3,750 hr. (*a*)	20,850			
3,660 ,, (*b*)			4,560	

* Calculated at ½d. per H.P. hour.

(*a*) 3,750 hr. = $\frac{\text{Annual output at Beckton}}{\text{Rated capacity of pumps}}$

(*b*) 3,660 hr. = $\frac{\text{Annual output at Grays}}{\text{Rated capacity of pumps}}$

It will be noted that there is a wide difference between the capital cost of plant as calculated from Appendix 4 of Mr. Lacey's Paper and the actual costs. This appears to be due to insufficient allowance having been made for the cost of connections, condensing plant, &c., when drawing up the original schedule of costs.

As regards running costs, it should be stated that both the plants referred to are running continuously but generally only at part load. At Beckton the plant is running at pressures of 1 to 2 lb. per sq.in. for the greater part of the year, while at Grays the pressure is usually 30 to 40 lb. per sq.in. In both cases the normal rate of output is between one-half and two-thirds the rated capacity.

The actual total pumping costs at Beckton are close to those calculated on the basis of hours at full load. This is accounted for by the efficiency of the large boiler plant which provides steam at low cost, and the small cost of attendance relative to the volume pumped. The smaller plant at Grays naturally has higher costs per horse power under both heads and there the actual costs approximate to the calculated costs for continuous running at full load.

† Trans. Inst. Gas Eng., 1927-28, 250.

MAINS COSTS.

During the past ten years wages and prices of pipes have been almost constant so that mainlaying costs have remained steady. Considerable lengths of large diameter mains have been laid on the Gas Light and Coke Company's area during this period and the average costs of these are shown in Table 6.

For each size of main the number of jobs and total length of main on which the averages are based are quoted to give some idea of the reliability of the figures, but it will be seen from the maximum and minimum rates given in the last two columns of the table that there is a wide variation, and the average costs can therefore be accepted only with caution.

The costs include special work such as bridge crossings, headings, &c., because, although these extras cannot perhaps be fairly allocated to cost per yard of main, it is seldom that any considerable length of main can be laid without some special difficulties of that type being met with along the route.

The average costs excluding and including reinstatement of paving are given, since the types of paving are so variable on different routes that the former figure is probably more useful for purposes of comparison.

It is interesting to compare these average costs with the rates quoted in Appendix II of the Paper entitled "Economic Aspects of High-Pressure Distribution," and those rates are set out in Table 6 in columns 5 and 7. In comparing the estimated rates with the actual costs it must be remembered that the former were based on a price of £8 per ton for cast iron, while the actual price has been rather lower.

It will be noted that the actual costs compare well with the estimated costs up to 18 in. diameter, but that for larger sizes the actual costs are higher and that the difference increases with increase in diameter. The estimated costs were intended to apply to long lengths of main laid across country or in rural districts, whereas the mains on which the actual costs are based were laid in urban areas and, particularly in the case of the 30 in. and 36 in. mains, along routes which included railway bridges and other obstacles which added considerably to the cost. It is also found that these larger sizes have usually to be laid at depths of 5 or 6 ft. through residential districts owing to the need for passing under house drains and other underground obstructions.

The following costs for smaller mains are based on laying on new estates, usually before the laying of paving, comparative figures (without reinstatement) from Mr. Lacey's Paper being also given:

	Actual.	Estimated.
	s. d.	s. d.
4 in. main, per yd. . . .	10 6	11 0
6 in. ,, ,, . . .	16 0	16 0
8 in. ,, ,, . . .	18 0	20 6

The following rates for steel mains with welded joints are based on experience in the Grays area of the Company:

	s. d.	
2 in. main	7 6	per yd.
4 in. ,, ...	12 6	,,
8 in. ,, ...	20 0	,,

COST OF SUPPLY TO NEWLY DEVELOPED AREAS.

In the two previous Sections of this Paper figures for cost of pumping and costs of mainlaying on the Gas Light and Coke Company's area have been given. In this Section examples are given of the costs of supplying suburban and country districts of the Company, and meeting the rapid development of these districts during recent years.

Three examples are given, viz., the Western area, the London County Council Becontree Estate and the Grays area.

The Western Area.

In January, 1926, the Brentford Gas Company was amalgamated with the Gas Light and Coke Company,

TABLE 6.—*Cost of Laying Large Mains.*

Size, In.	No. of Jobs.	Total Length, Yd.	Average Cost per Yd., Excluding Reinstatement.		Average Cost per Yd., Including Reinstatement.		Actual Cost per Yd., Including Reinstatement.	
			Actual.	Estimated.	Actual.	Estimated.	Maximum.	Minimum.
1	2	3	4	5	6	7	8	9
			£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
12	6	8,189	1 12	1 13	1 16	2 0	2 4	1 7
14	7	13,033	2 2	2 2	2 8	2 10	3 8	2 4
18	10	20,479	3 4	3 1	3 10	3 10	4 18	2 14
24	10	22,987	5 4	4 9	5 16	5 0	7 14	3 14
30	3	11,523	7 14	6 1	8 6	6 15	9 8	7 6
36	3	17,679	11 10	8 2	13 14	9 0	15 16	11 8

thereby adding 130 square miles to the latter Company's area of supply. Parts of the Brentford Company's area had been fully developed for many years, but much of the district was undeveloped, especially west of Hounslow and in the Harrow area. The rate of building in these districts had been increasing for some years prior to the amalgamation and this development has continued still more rapidly during the past ten years, so that the greater part of the area is now fully developed.

In 1930 the Pinner Gas Company was amalgamated with the Gas Light and Coke Company, adding a further 25 square miles to the area, and intensive development of this district has taken place during the past seven years.

For the purposes of this Paper, the Pinner and Brentford areas are considered together as the Western area.

At the time of the amalgamation the supply on the Western area was almost entirely at low pressure, there being no feeder mains except a 30 in. inter-works main between the Southall and Brentford Works, with an 18 in. branch to Alperton, and a second 30 in. main from Southall to Hammersmith which was untapped for the first 4 miles, *i.e.*, as far as Ealing.

It was decided to link up these two 30 in. mains with the Beckton grid system which then terminated at Kensal Green, to build up a feeder main system to meet the needs of development in the new area, and to link up the other manufacturing stations—Richmond, Staines and Harrow—to the grid system. This system was later extended to the Pinner district.

During the ten years from January, 1926, to December, 1935 (in the case of the Pinner area from January, 1930), 142,100 new houses have been supplied on these areas and Table 7 shows the lengths and sizes of mains laid for the supply of this development. The total length of local mains is about 800 miles, equivalent to 10 yd. per house. The costs for the local mains have been estimated on the basis of costs previously quoted. The costs given for the feeder mains are actual costs. The area is now supplied through 39 distributing centres, *i.e.*, 4 manufacturing stations, 5 holder stations and 30 underground governors.

The average annual consumption per ordinary consumer on the newly developed parts of this area is about 200 therms and that for automatic supplies about 100 therms; as the majority of the new consumers have automatic supplies, a figure of 125 therms has been used for calculating the annual charge per therm in the last column of the Table.

TABLE 7.—*Western Area—Mains Laid* 1926 *to* 1935.

Size of Main, In.	Length Laid, Miles.	Cost per Mile (Estimated).	Total Cost.	Cost per House.	Annual Charge per Therm.
1	2	3	4	5	6
Local Mains.					
		£	£		
4	383	924	353,900		
6	276	1,408	388,600		
8	107	1,584	169,500		
12	28	3,168	88,700		
18	2·5	6,160	15,400		
Total	796·5	..	£1,016,100	£7 3 0	1·10d.
Feeder Mains.					
			£		
14 and under 18	8		20,052		
18	11·2		76,176		
24	11·1		115,165		
30	2·9		36,731		
36	3·9		79,065		
Total	37·1	..	£327,189	£2 6 1	0·35d.
Total cost of mains .			£1,343,289	£9 9 1	1·45d.

London County Council Becontree Estate.

In 1920 the London County Council commenced the building of a large estate, for housing the working classes, at Becontree in Essex, about 4 miles north-east of Beckton. This estate consists of 24,000 houses, and additional houses and shops have been built by private enterprise, making a total of approximately 25,000 in all. The estate was completed in 1934 and covers an area of about 5 square miles, being approximately rectangular in shape and extending 2 miles from E. to W. and 2½ miles from N. to S.

Nearly 95 miles of mains of sizes 4 in. to 12 in. have been laid for the local supply of the estate (equivalent to 6⅔ yd. per house) and these are fed through six underground governors by a system of feeder mains, of sizes 18 in. to 30 in., from the Beckton station of the Company. Five of the underground governors are situated at approximately equal intervals round the estate and the sixth is near the centre.

The total cost of the feeder mains was £77,000, but since these also supply several holder stations and, through the governors referred to above, the districts surrounding the estate, only half the total cost, viz., £38,500, can properly be allocated to the supply of the estate.

Table 8 shows the lengths and estimated costs of the local mains, together with the cost of the feeder mains, and the cost per house and annual charge per therm. The average annual consumption per automatic consumer on this part of the Company's area is 110 therms, and this figure has been used in calculating the annual charge per therm.

TABLE 8.—*Becontree Estate—Mains Laid* 1920 *to* 1934.

Size of Main, In.	Length Laid, Miles.	Cost per Mile (Estimated).	Total Cost.	Cost per House.	Annual Charge per Therm.
1	2	3	4	5	6
Local Mains.					
		£	£		
4	49·0	924	45,300		
6	30 3	1,408	42,700		
8	6·5	1,584	10,300		
12	8·9	3,168	28,200		
Total cost of local mains .			£126,500	£5 1 2	0·88d.
Cost of feeder mains. . .			38,500	1 10 10	0·27d.
Total cost of mains . . .			£165,000	£6 12 0	1·15d

The Grays Area.

In 1930 the Grays and Tilbury Gas Company was amalgamated with the Gas Light and Coke Company, the added area, including Canvey Island, which was not brought into the statutory area of supply until 1933, being 179 square miles.

The Grays area is of a rural character, there being only three or four districts which can be called urban and a number of small villages. There is, however, a considerable amount of "bungaloid" development of a very scattered and haphazard type, and the distribution of gas is therefore expensive. The Grays Company had in 1913 commenced the development of a high pressure system for the supply of the villages and this had reached considerable proportions at the time of the amalgamation, the total length of high pressure main being 77 miles. The system consisted of steel mains of sizes 1 in. to 6 in. and the gas was compressed to 30 lb. per sq.in. Consumers were supplied through service governors direct from the high pressure mains.

This high pressure system has been extended rapidly during the past seven years both for the supply of new bungalows and to serve a number of villages and scattered houses not previously connected to the system, the total length of mains laid being 301 miles. The number of additional consumers is 24,538.

The lengths and sizes of mains laid are shown in Table 9, together with the estimated cost.

There are certain parts of the Grays area supplied at low pressure, either from holder stations or through main governors, and it has not been practicable to separate the mains laid on these parts from the total. Similarly the number of additional consumers includes those supplied at low pressure. As, however, the great majority of the extensions have been on the high pressure system, the value of the figures is not seriously reduced by the inclusion of low pressure supplies.

The average automatic supply consumption on this area is 75 therms per annum and this has been used in calculating the annual charge per therm.

TABLE 9.—*Grays Area—Mains Laid* 1930 *to* 1936.

Size of Main, In.	Length Laid, Miles.	Cost per Mile (Estimated).	Total Cost	Cost per House.	Annual Charge per Therm.
1	2	3	4	5	6
		£	£		
1	11·8	440	5,200		
2	169·0	660	111,500		
4	81·9	1,100	90,100		
6	8·5	1,408	12,000		
8	30·2	1,760	53,200		
Total	301·4	..	£272,000	£11 1 8	2·83d.

The costs of supply given in Tables 7, 8 and 9 refer only to the costs of mains and the annual charge in respect

thereof, but it is of course necessary to add the cost of pumping in order to arrive at the true cost per therm distributed. Table 10 gives a summary of the charge per therm for mains, extracted from the previous tables, together with the pumping costs as previously set out. The cost for pumping on the Western area is taken as the grid cost, while for the Becontree estate, which is fed direct from Beckton, the cost of pumping at Beckton has been adopted.

TABLE 10.—*Charge per Therm in Pence.*

—	Western Area.	Becontree Estate.	Grays Area.
1	2	3	4
Local mains	1·10	0·88	
Feeder mains	0·35	0·27	
Total for mains	1·45	1·15	2·83
Pumping	0·074	0·056	0·79
Total	1·52	1·21	3·62

ECONOMIC SIZES OF MAINS AND INITIAL PRESSURES.

It is not practicable to apply in detail the process laid down in " Economic Aspects of High Pressure Distribution " when planning a feeder mains system because the various branches of the system are interdependent and a similar range of pressures must be used throughout the system. In addition, the loads to be dealt with by the various mains cannot generally be forecast with any degree of accuracy and sufficient margin of capacity must be allowed to meet future developments and extensions.

Fortunately, however, the combined main and pumping cost does not vary to any great extent over a group of sizes of main close to the theoretically ideal size, as may be seen from the example given in Mr. Lacey's Paper.

On the grid system of the Gas Light and Coke Company the gas is first pumped from Beckton and is re-pumped at Fulham, Kensal Green and Southall, and the greatest distance covered in one pumping stage is about 10 miles—the average distance of distribution on the feeder mains is between 5 and 10 miles.

Table 11 shows the economic size of mains and economic initial pressure, worked out in the way described in Mr. Lacey's Paper, for various rates of pumping and for distances of 5 and 10 miles. It will be seen that the sizes of main vary from 18 in. to 36 in. diameter, and the economic pressures from 1 to 2·9 lb. per sq. in. While this does not prove that the feeder main system described above is laid out in the most economical manner, it does show that the grid pressures of 1 to 3 lb. per sq.in. and the sizes of mains used are within the economic range.

TABLE 11.—*Economic Sizes and Initial Pressures for Different Rates of Pumping.*

—	Volume Pumped. Cu.Ft. per Hr.							
	200,000.		350,000.		500,000.		1,000,000.	
	5 Miles.	10 Miles.	5 Miles.	10 Miles.	5 Miles.	10 Miles.	5 Miles.	10 Miles.
1	2	3	4	5	6	7	8	9
Economic size of main, in.	18	18	24	24	30	30	36	36
Economic initial pressure, lb. per sq.in.	1·7	2·9	1·3	2·2	1·0	1·6	1·3	2·2

Reference has already been made to the two 48 in. diameter mains through which most of the gas made at Beckton is pumped to the City of London, a distance of about 10 miles. At peak load these mains each carry 2 mill. cu.ft. per hr. and for this load a 48 in. main is the economic size, the economic initial pressure being 2·2 lb. per sq.in. This initial pressure is based on a terminal pressure of 8 in. w.g. Actually a pressure of about 20 in. w.g. is generally maintained at the City end of these mains, so that the maximum pressure of 3 lb. per sq.in. at Beckton conforms closely with the theoretical initial pressure. These mains were originally laid for operation at holder pressure and it is a remarkable and fortunate coincidence that the capacity of the mains should be so close to present-day requirements.

While it is unlikely that anyone would dispute the advantages of using feeder mains for the supply of large areas, it is perhaps worth while to point out that the figures in Table 10 show that the cost of pumping, for the Western area, amounts to only one-fifth of the annual charge for feeder mains; in other words, a low pressure system would be more expensive if the cost of low pressure trunk mains exceeded the cost of the feeder mains by more than 20 per cent.

The pressure losses on the feeder mains are of the order of 5 in. w.g. per mile and not more than 1/10th of this loss could be allowed on low pressure trunk mains. The diameter of equivalent low pressure mains would therefore be $\sqrt[5]{10}$ or 1·6 times that of the feeder mains.

From the mainlaying costs given in Table 6 it will be seen that the cost of equivalent low pressure mains would be nearly double that of the feeder mains, so that the additional annual cost would be nearly five times the cost of pumping.

The Grays distribution system extends for a distance of about 20 miles and the principal feeder mains are an 8 in. diameter main laid through the centre of the district from Grays to Rayleigh and a 6 in. main, which splits into two 4 in. mains, through the southern part of the area. The maximum rate of demand on the system is 150,000 cu.ft. per hr. and of this two-thirds may be considered as being carried by the 8 in. main and one-third by the 6 in. main, although of course these mains are interconnected and there are other smaller mains running parallel to them which serve to carry part of the load.

The initial pressure is about 35 lb. per sq.in. and a pressure of not less than 10 lb. per sq.in. is held at the end of the feeder mains in order to allow for pressure losses in the long branch mains, most of which are of 2 in. diameter. The pressure drop in the feeder mains is therefore about 25 lb. per sq.in.

With the present load these mains are smaller than the economic size and the initial pressure is consequently higher than the economic pressure, but the rate of increase in demand on this area has been exceptionally high during the past five years—the peak load has nearly trebled in this period—and it is not practicable to design a system to operate under the most economic conditions when the load is increasing so rapidly that the economic pressure and size of main changes from year to year. This is particularly true in the case of small mains and high initial pressures, such a system being much less flexible than a medium pressure system.

It is intended to meet further increases in demand during the next few years by the installation of high pressure static storage vessels at various parts of the district so that the peak load may be met by supplying from these holders and an increase of pumping pressures avoided. A start was made with this scheme last year by the installation of a " Hortonsphere " of a working capacity of 100,000 cu.ft. at Canvey Island, and this has proved very useful.

It will be seen from Table 10 that the cost of pumping is approximately one-quarter of the charge for mains and it is obvious that the cost of distribution would be much increased if the district were supplied by low pressure local mains and a feeder system. The 2 in. mains would have to be replaced by 4 in. and 6 in. mains at an increased cost of 50 per cent. to 100 per cent., and the cost of the feeder mains would be at least double that of the present system, and probably much more.

DISTRIBUTION PRACTICE.

Pipes.

Cast iron pipes with half turned and bored joints, the front part of the joint being run with lead, are normally used for all low pressure mains. Cast iron mains are also used for the medium pressure feeder main system, but recent experience of the half turned and bored joint at these pressures has not been satisfactory and for the last four years a combination joint—lead wool, rubber ring, leaded yarn and run lead, a modification of the Lead Wool Company's patent joint—has been used for these mains.

Two short lengths of 6 in. main with the Stanton-Wilson joint were laid in 1930 and these have proved quite satisfactory to date. Some 2 miles of 14 in. main with the same joint were laid as a branch from the feeder main system in 1935 and these have also proved satisfactory.

Spun iron pipes of the type cast in sand-lined moulds have been used extensively, but few of those cast in metal moulds have been used, except those with the Stanton-Wilson joint referred to above, because this type cannot be obtained with a satisfactory half turned and bored joint.

Steel mains with welded joints are used for all high pressure mains in the Grays area and for medium pressure mains of less than 12 in. diameter. Steel is also used for low pressure mains in situations where subsidence is likely to take place, *e.g.*, when it is necessary to lay close to a sewer trench, as frequently happens on estates where the sewers are laid in both footpaths.

Steel tubing is used for service pipes, these being protected either by wrapping or by cement or pitch in troughing.

Plant.

The only types of special plant used in connection with main laying are mobile air compressors for operating concrete breakers, and rammers of the explosion type, *e.g.*, Pegson and Johnson rammers. Mechanical excavators have seldom been used as these are considered unsuitable for use in built-up areas where there are many other pipes, cables, etc., and would not be economical on new estates, partly because of obstructions due to builders' materials, etc., and partly because only relatively short lengths of trench can be opened at one time. Hand and power operated cutting machines are used when cutting out mains of 18 in. diameter and upwards. For connections on smaller mains the split tee is generally used, the hole for the branch being drilled under pressure.

CONCLUSION.

The Author feels that it is very desirable that the experience of the many individual members of this Institution in regard to plant and materials used in the distribution of gas should be made available to other members in a more systematic manner than has hitherto prevailed.

During the course of a year several Papers are contributed to this Institution or to the District Associations in which the authors give their experience of this or that material or method of main laying, but there must be much valuable experience which is never made known to the Gas Industry as a whole.

Mains and services are expected to have a very long life and few of us can carry out tests which provide adequate proof of the behaviour of new materials within a reasonable time. If, however, the results of a large number of short tests could be collected, it would to some extent compensate for the absence of more lengthy experience.

The Author is Chairman of the Pipes Committee of the Institution and, although he is not now speaking in that capacity, he would seriously appeal to members to send to that Committee particulars of their experience with all relatively new materials or apparatus used in connection with distribution work. Information collected in this way would, it is felt, be far more satisfactory than the sending out of lengthy questionnaires on these subjects. Questionnaires are generally rather a nuisance and can seldom be framed so as to obtain all the relevant facts. If each member who has made any interesting experiments or trials of new materials or apparatus would send a note of his work to the Pipes Committee, these notes could be analyzed and correlated and abstracts circulated or included in the Committee's Reports.

TECHNICAL ASPECTS OF

Communication No. 157

The Holding Company Movement

by
G. M. GILL
(Director, Severn Valley Gas Corporation, Ltd., and Gas Consolidation, Ltd.)

The subject of Holding Companies has been very much to the fore during the past few years, and while there have been some advocates, there have been a good many opponents. In this Paper, the Author does not wish to plead the cause of the Holding Companies, but rather to set out a plain statement of fact as to the methods adopted by two Holding Companies with which he has been closely identified since their inception. The two Companies in question are the Severn Valley Gas Corporation Limited and Gas Consolidation Limited, and between them they control 36 Companies which made during the past 12 months 4,135 mill. cu.ft. of gas of a quality varying from 450 to 520 B.Th.U. per cu.ft. The average size of Company represents, therefore, a make of 115 mill. cu.ft. of gas per annum.

Of these Companies:

*15	make	less	than	25	mill.	cu.ft.	per	annum
7	,,	over	25	but under	50	mill.	cu.ft.	per annum
4	,,	,,	50	,,	100	,,	,,	,,
4	,,	,,	100	,,	250	,,	,,	,,
4	,,	,,	250	,,	500	,,	,,	,,
2	,,	,,	500	mill.	cu ft.	per	annum	

* The works of five of these have been, or are being, shut down as manufacturing stations.

FINANCIAL ASPECTS OF HOLDING COMPANIES.

Since this is a technical Institution, it is not proposed to follow too closely the financial aspects of the Holding Companies and their operations. The Author would, however, make it clear that the Holding Companies do not, except in special cases, buy Gas Companies lock, stock and barrel, but merely buy the majority of the ordinary shares in a Company. There is, therefore, no change in the identity of the Company, which retains its name, its Acts of Parliament, Board of Trade Orders and its Articles of Association. The only change which takes place is in the shareholders and the Board of Directors. Most of the latter are compensated, their places being taken by nominees of the Holding Company. The fees paid to the old Directors then accrue to the Holding Companies. This brief explanation is given because so often those concerned with Companies have the idea that a Company has been sold to a Holding Company. This is quite incorrect. In cases where Municipal Gas Undertakings have been sold to a Holding Company, the case is different and the Undertaking itself is sold lock, stock and barrel to a new local Company formed by the Holding Company.

It is sometimes said that the Holding Companies have paid prices for Companies' shares which are so high that the subsidiary Company in question becomes overcapitalized. While this may have the effect of overcapitalizing the Holding Company, it cannot add a single pound to the capitalization of the local Company the shares of which are purchased. The only people who suffer if too high a price be paid are the shareholders of the Holding Companies. The same critic would then say that as the Holding Company paid too high a price for the shares of the Company in question, it must follow that the Holding Company will have to extort money from its subsidiary in some shape or other to pay interest on the Holding Company's investment.

This might be so if the gas business were still a monopoly, but as all in this Institution will know only too well, the gas business is highly competitive and it is not possible to increase the revenue and the rates of dividends paid by merely raising the price of gas. There would be a great outcry if it were possible to increase the price of gas and the rate of dividend simultaneously. As we all know, this cannot be done, and no one of experience in the Gas Industry would contemplate the carrying out of so ridiculous a policy. Accordingly, if the Holding Companies pay too high a price, then their own shareholders will suffer. It is known full well that the only way in which a Gas Company can prosper is by selling gas at a reasonable price and by giving a good service to its customers, and so long as that policy is diligently followed progress should be made.

In regard to the financial aspect generally, the association of a Company, especially if it be a small one, with a Holding Company carries with it important advantages to the subsidiary. Such a Company can obtain money without difficulty to finance its requirements, either by means of bank overdrafts, guaranteed if necessary by the Holding Company, or by direct loans from the Holding Company, or by an issue of Share or Loan Capital. The Holding Companies have been able to make arrangements with all the subsidiary Companies' Bankers, whereby they can obtain their requirements much more cheaply than they had been able to do in the past, while expert advice on the question of issues of capital has obtained for the various companies concerned, most advantageous terms of issue. It should be stated that the Holding Companies have made no separate charge for services of this character.

Such financial arrangements have given to many of the Companies with which the Author is concerned new money upon terms which have made capital expenditure not only practicable, but more remunerative.

Considerable sums of money are required by progressive Companies to finance the large business which is now being done in selling modern gas appliances on long term hire purchase contracts. Many of us know that this is the only means by which we can persuade our customers to install modern appliances, and we feel that this is necessary if we are to secure our future position. Local Boards of Directors have not the knowledge which the Boards of

Holding Companies possess, and often shelve the question, as it entails the locking up of a large amount of money, which they may or may not be able to procure, and of the wisdom of which they are doubtful.

With the activity which has been introduced into the management of the various subsidiary Companies which are now controlled, it has been necessary to arrange for financing such activities. Issues to the amount of £345,000 have been made, of which £330,000 was in the form of 3½ per cent. debentures, issued at prices varying from 97½ to 100. For two small Companies £15,000 4½ per cent. preference stock has been issued at par.

This new money together with bank overdrafts has been wanted to finance the extensive additional sales of modern gas appliances under hire purchase conditions already referred to and of new plant to which reference is made below. It is the opinion of the Companies with which the Author is connected that their subsidiary Companies, taken as a whole, could not have done nearly as well in this matter of raising new capital or obtaining bank overdrafts, as has been possible with the help of the Holding Companies.

In these Companies, the result of Holding Company control has been the placing of many orders for new and improved plant which was never contemplated by the old Boards of Directors. Orders which can be placed in this category have amounted to over £120,000 for new plant of a varied nature, chiefly comprising carbonizing, coke handling and benzole plant, and gasholders. In addition to this, many new extensions of mains have been carried out which, it may confidently be said, would not have been tackled under the old régime.

Of the 36 Works originally in operation before association with the Holding Companies, 7, which were uneconomic in operation, have been or are being shut down and supplies taken from other Works, or in one case from a Coke Oven plant. This has involved or will involve the laying of 29 miles of new main.

Wise expenditure and enterprise have been the keynote throughout, and it must be agreed that while money is cheap the opportunity should be taken of incurring inevitable expenditure and that such expenditure should not be postponed until money is again dear, as must happen as surely as night follows day.

PERSONNEL.

It will be argued that a thoroughly good Board of Directors with a capable Engineer and Manager would in any case follow precisely the policy which is outlined above. That is true, but such a combination is comparatively infrequent and, even where it can be found it is doubtful if it can compare with the expert attention and advice which the subsidiary Companies can command. We have, however, to deal with the majority, and it is no good mincing matters and thinking that everything is all right when we know perfectly well that this is not the case. In the past, due to the fine character of the gas business, it was possible to prosper and pay good dividends without any special effort on our part, but those days are past, and we have now to put our backs into the business.

Directors.

On the Boards of the two Holding Companies mentioned above there are four Directors who have special duties as follows:

(1) The Chairman of the two Holding Companies, who is head of a Merchant Banking House, has devoted a great deal of time to the problem of financing all their operations in the most advantageous manner. On this subject he has had long experience.

(2) A Director who is a fully qualified gas engineer and manager and devotes virtually his whole time to the administration and technical control of the Companies in the group. He is in close contact with all the Companies by correspondence and makes frequent visits to the districts concerned.

(3) A Director who is a fully qualified gas engineer and advises the management of the various Companies in all matters pertaining to income-tax, rating and accounts and in special matters such as tariff charges. In these special matters and in others also he is an acknowledged specialist of considerable experience, and his help has enabled material savings to be made in the direction of income-tax and rating, which matters have always received attention as soon as control of a Company has been obtained.

The two gas engineer Directors collaborate with the local engineers regarding new plant and mains extensions.

The above Directors are in close contact with each other in regard to special matters affecting the management of the Companies.

(4) A Director with a considerable experience in business and in Gas Company administration, in charge of negotiations with such Gas Undertakings as may join the group. His work consists of visiting and interviewing Directors and Managers, of explaining the working of the group system, and also of discussing and arranging terms of purchase.

Apart from the above special Directors, there are four other Directors, all of whom are prominent men in the business world.

Special Staff.

In dealing with a large number of controlled Companies, it has been found advisable to employ the following special staff:

Secretarial and Financial.

(1) A Solicitor, who is Joint Secretary of the Holding Companies and also a Director of a number of the Companies, trained in Parliamentary work, gas legislation and in the ordinary legal duties. The Acts of Parliament and Board of Trade Orders have come under review in each case, and have been the subject of scrutiny by the Solicitor, who has had special training and experience in such class of work and with whose help very definite progress has been made.

(2) A Joint Secretary of the Holding Companies acts also as the Chief of Staff to the Chairman, and is experienced in financial and secretarial affairs.

(3) A Comptroller of Purchases, who is assisted by a Committee of Managers to study the various requirements of materials by the subsidiary Companies with a view to making Holding Company contracts for such materials as are required in quantities. When the contracts are made, the details are circulated to the Companies, any of which can requisition their requirements on such contracts. In such cases, the Company concerned receives the goods and the accounts which it settles monthly. The Comptroller of Purchases is sent copies of all orders placed by the subsidiary Companies and is thereby kept in touch with what is being done. With this system the amount of extra work involved is reduced to a minimum and the advantages obtained in the matter of reduced prices for materials is realized with a small reduction only for the cost of working the system. The work carried out by the Comptroller of Purchases has resulted in considerable savings to the Companies.

(4) A Travelling Accountant, skilled in Gas Companies' accounts, to visit the Companies and make up, where necessary, half-yearly and yearly accounts ready for auditors and to advise on necessary alterations in book-keeping and accounts.

In the matter of yearly accounts and book-keeping methods generally, it will be no news to the members of the Institution to learn that the balance sheet and accounts of many Companies, and especially those of smaller size, are altogether too incomplete to give the Directors and shareholders a proper idea of the state of affairs. With the Directors and staff which we have, and with the assistance of the Travelling Accountant, we have been able to overhaul and bring about a very necessary improvement in presenting the accounts and in the adoption of proper book-keeping methods.

Technical.

(1) A specialist in carbonizing, who visits all Works and advises on retort house operation and assists in carrying out alterations in working routine, where it is deemed advisable.

It was considered that a Company's working results depended so much upon the results obtained in the retort house that it was decided to employ a man with special carbonizing experience, and his help has been found very valuable. It is his duty to pay periodical visits to all the Works and note the condition of the plant and the efficiency being obtained with the object of advising in the matter of improvements. Even a small improvement in carbonizing means a considerable saving of money, and the Companies have had every reason to be satisfied with their enterprise in this respect.

(2) Travelling Chemists, of which there are three in this Group, to visit all the Works which are too small to employ a trained chemist. These chemists work from a central laboratory and travel by car with the necessary chemical apparatus to enable them to carry out routine and other chemical tests at the various Gas Works. It is their duty to keep all chemical apparatus and testing equipment in good order at all the Works.

As regards the work done by the Travelling Chemists, it has been found of great advantage to install proper testing and recording equipment at each of the Works, this being kept in order by the chemists. The local manager is by this means enabled to know what he is doing and to run his plant more intelligently. We have installed in all Works recording calorimeters, and these are kept working

correctly by the Travelling Chemist. During his visits he tests the purifiers and takes samples of the purifying material and coal which he tests in his laboratory. He takes pyrometric readings of the retort settings and assists where necessary in the regulation of the settings. He tests the gas, not only for its calorific value, but also for its specific gravity, oxygen content and percentage of inerts. On these matters he advises the local manager with a view to improvements being made. His visits will occupy 1 to 3 hours weekly at each Works. It has been an invaluable service and has resulted in all the smaller Companies making a better and more uniform gas and a gas which is better for the consumers. With the help of the chemists, the making of good and uniform gas at all times has been one of the chief aims of the Companies, who believe that in the building up of the gas business it is of paramount importance that the product itself should be entirely satisfactory and reliable.

(3) A Consulting Chemist who co-ordinates the chemists' work, visits all Works from time to time and deals with special problems as these arise.

(4) A Mechanical Engineer who is specially skilled in gas engines and gives a regular service to gas engine users in all the areas supplied. This service has resulted in a number of gas engines being retained and others replaced by new or good second-hand engines. He is also responsible for keeping in good condition the mechanical plant at all the smaller Works, where there are no trained mechanics. This man has an assistant who is a trained Gas Works fitter and erector.

In a number of the smaller Works it has been found that there is insufficient knowledge of mechanical plant, and as a consequence exhausters, engines, pumps, boosters and other mechanical plant does not receive the attention which is necessary to keep it in good working condition. As a result, it was decided to employ the Mechanical Engineer, whose duty it is to pay periodical visits and take in hand the overhaul of such plant. His services have also been specially useful in removing disused plant from larger Works to smaller Works where such plant will have a new lease of life.

(5) A Gasholder Erector with a long and specialized experience of gasholders. This man deals with all the ordinary repairs of the gasholders in the group, these numbering 112 holders in all. With his assistance it is not necessary to employ holder builders to carry out the numerous jobs of lesser importance which must be done to keep holders in good trim. This man has two assistants and engages local labour as required or borrows from the Companies where he is doing the work.

Sales and Service.

(1) Five trained Salesmen who are lent to such Companies as have not competent salesmen on their staff. These men take temporary charge of the district work in the case of the smaller Companies and organize this work on modern and progressive lines with the object of giving good service to the consumers and of selling modern gas appliances for cash or on long-term hire purchase.

In connection with their work a number of pressure recorders which belong to the Holding Companies are used to enable a proper investigation to be made of the pressures at all parts of the district. Such investigations usually disclose that some new mains or the looping of existing mains are required or that holders should, where suitable, be weighted to give increased pressures or that a booster should be installed. It is considered that a necessary preliminary to a campaign on the district is the making of a good and uniform gas of the required quality and the maintenance of sufficient pressure to all parts of the district. In all cases these problems have received attention soon after obtaining control of a Company.

As part of the campaign to sell more gas and appliances, it has been found advantageous to institute a census and canvassing scheme, and that not only is a census of each consumer's conditions and appliances very useful and almost indispensable, but also that the value of the orders for new appliances obtained and of the service given by the fitters who make the census is sufficient to cover the cost of making the census.

The temporary lending of salesmen to subsidiary Companies has been found very effective, not only in the quantity of sales which has resulted during their stay, but in the subsequent benefit which accrues in the form of satisfactory monthly sales after they have left.

To give an idea of the sales of appliances resulting during these visits of salesmen, it might be stated that these have amounted to an average of £26 per week, with a maximum of £48 and a minimum of £15. During these visits a large number of Census Cards of consumers' appliances have been filled in, which work should also be credited against the expense of the salesman.

The special District Staff is assisted by two Travelling Showrooms, of which one is of a type which opens out into a large room 21 ft. square and has to be transported by a lorry, while the other is a motor coach which has been suitably altered and fitted up as a showroom. The latter is more mobile and is equipped with a loudspeaker by means of which it can advertise its presence.

To give some idea of the sales effected by these travelling showrooms the figure in the case of the first mentioned has amounted to a weekly average of £68, and sales totalling £3,272 have resulted since it was put into commission. In the case of the second, the weekly average has been £87, and the total sales have amounted to £3,141.

In most cases it has been found that the local management is very ready to co-operate with any special staff supplied by the Holding Companies and to make a real success of any campaign which may be launched. It has been the practice to collect monthly data of the sales of appliances in the case of each Company and to prepare a comparison of the results obtained in all cases. For the purposes of comparison all chargeable work completed and all sales made during each month are included as sales. Included in the sales of appliances are the amounts which are paid or will become payable by the consumer over the deferred payment period. The monthly figures are based upon the amount of sales of appliances per mill. cu.ft. (corrected to 500 B.Th.U.) sold in the previous 12 months, but for the purpose of each month's result the previous year's sales of gas is divided by 12. Thus, if the monthly sales amounted to £500 and the previous year's sale of gas was 120 mill. cu.ft. of 500 B.Th.U., then the monthly sales of appliances, etc., viz., £500 divided by the average monthly sale of gas in mill. cu.ft., would give a result of £50 of appliances per mill. cu.ft. sold.

It is found in practice that the monthly sales of appliances on the above basis vary for the most part between £30 and £100 per mill. cu.ft. Special activity in the case of any Company would increase the figure to over £100 per mill. cu.ft., and this has happened on numerous occasions as a result of special campaigns and during the periods when the Travelling Showrooms have been in the district.

The annual figures in the case of the Companies which have been in the Group for the past 12 months show a variation between £138 and £38 per mill. cu.ft., with a true average for all the Companies of £58 per mill. cu.ft.

Eight showrooms have been opened in districts of Companies which did not previously have a showroom, and these have, in all cases, been a success and have well warranted the initial outlay and the additional annual expenditure entailed.

(2) An Industrial Gas Salesman, with many years' experience of industrial heating problems, both with oil and gas, has been a member of the staff for the past 1½ years. It is his duty to keep in close contact with all prospects in this direction, to assist the local managements with all industrial gas problems, and to keep up-to-date in all the new methods of using gas for the various industrial processes. As he has not up to the present been fully occupied with industrial gas problems, being a trained salesman he is also in charge of the coke sales of one of the largest of the Companies.

These Holding Companies belong to the Midland Industrial Gas Centre and this enables all controlled Companies to obtain any information or assistance they may require from that Centre. It is the duty of the Industrial Gas Salesman to act as the liaison between the Centre and the Companies and to be ready at all times to tackle any industrial gas problems which require special qualifications. It is difficult, if not impossible, for the managers of Companies to keep sufficiently up-to-date in industrial gas matters to be able to advise adequately the factory owners and others who wish to consider the use of gas for their individual purposes.

It is difficult to assess the actual results of the work of this industrial gas salesman, but it would be no exaggeration to state that new industrial gas consumption in a number of different directions has been obtained to the amount of about 50 mill. cu.ft. per annum. It is probable that much of this new business would not have been obtained without the advantage of his services.

Works.

(1) A Gas Works Foreman who is a trained gas maker with considerable experience. This man is used in cases where Works need a general reorganization and where a suitable man is needed to put the plant in good working condition. He is also used to relieve managers who are ill or on holiday.

(2) A Consulting Fuel Technologist, who has an exceptional knowledge of coals and other fuels. He assists in the selection of coal at the various Works.

It was considered that much could be done by the skilful selection of coal for the various Works, and to this end one small nine million Works was fitted up as a coal

testing plant. This Works, at which is located one of the central laboratories, the headquarters of one of the travelling chemists, is in normal operation and supplies a large village with a population of 1,755. The Gas Works and the laboratory were equipped with all that was necessary to carry out with accuracy practical coal tests. No sooner had a good start been made with the testing of all the coals in use than the attempt was stultified by the machinations of the coal selling schemes, one idea of which appears to be that the buyer must, willy-nilly, continue to purchase the same coal as in the past.

With the above staff, most of the problems with which the group of Companies is confronted can be tackled with success, and matters which would be very complicated to the ordinary Directors of Gas Companies have been made quite simple and have received expert attention promptly and at a cost which has been much less than would have been the case with an isolated Company of medium or small size.

In many cases local Directors have been elected on the Boards. These gentlemen have special knowledge of their towns and of the inhabitants, and are helpful in many ways. Local Directors' fees are paid by the Holding Companies.

As an example of useful co-operation it might be stated that the Holding Companies have already purchased a quantity of special equipment for use by the various subsidiary Companies which would not be justified in incurring such expenditure for their sole use.

Another example has been the long term hire by the Holding Companies of a considerable number of modern types of railway wagons for use by the subsidiary Companies.

CONTRIBUTIONS FROM SUBSIDIARY COMPANIES.

It is obvious that the system outlined above cannot be carried out without reasonable contributions from the subsidiary Companies. In the case in point, these are based upon the gross revenue received by the various Companies. The operating charge is based on the gross revenue for the year as shown in the printed accounts, *i.e.*, the receipts for gas, residuals and meter and stove rentals, excluding any other receipts, such as profit on fittings, etc., and is made up on the following block rate:

2½	per cent. on first	£5,000	of gross revenue
1¼	,, ,, next	£20,000	,, ,,
¾	,, ,, next	£20,000	,, ,,
½	,, ,, all above	£45,000	,, ,,

Where a Company takes its supply in bulk or uses coke oven gas, the figure resulting from the above scale is reduced by one-third.

In addition to the above, the Holding Companies receive 2½ per cent. on all goods bought under the Special Contracts Scheme and 1¼ per cent. on coal contracts made. By means of these special contracts the Companies under their control can obtain their requirements more cheaply after paying such percentage to the Holding Company than by buying outside the Scheme. Special charges are made only in the following instances:

(1) For detailed advice given in connection with income-tax and rating.

(2) For legal work in obtaining new Acts of Parliament or Board of Trade Orders.

(3) For advice—but only if required—in connection with constructional work, in which case the charge is 2½ per cent. on the first £200 and 1¼ per cent. on cost in excess of this figure.

Under this system the Gas Companies controlled by the Holding Companies obtain expert advice at the cheapest possible cost.

The Directors' fees paid by the various Companies are paid directly to the Holding Companies which are responsible for the payment of all their nominee Directors who serve on the Boards of the various subsidiary Companies.

As explained elsewhere in this Paper, it has been the policy of the Holding Companies, wherever possible, to reduce the price of gas, but circumstances in this respect have not been propitious. In 22 Companies the price of gas has been maintained at the same rates, although in most cases special contracts at lower rates have been made for gas used for industrial and commercial purposes. In 6 Companies the price of gas has been reduced by the introduction of attractive block scales. In one Company the price of gas was increased by 0·2d. per therm.

The rise in the price of coal and other materials, and also of labour, has prevented a more or less universal introduction of attractive block scales.

As regards the rates of dividend which have been paid since the Companies came under the control of the Holding Companies, all are paying the same rates of dividend, except two which are paying increased and three paying decreased rates.

CONCLUSION.

The above sets out the general methods and policy adopted in the case of the Holding Companies with which the Author is concerned. The work is new in character and there was little or no experience to guide them in the best methods to employ. Time may show that they can make changes in their methods with advantage, in which case they will not be slow to cut out what is redundant and to introduce what is likely to be advantageous. They have no use for red tape and they want to be progressive. They are anxious to act in the best interests of the Gas Industry and to play their part in maintaining and improving the position of the Industry.

THE FUTURE OF Gas Appliance Design

Communication No. 158

by
C. A. MASTERMAN
(Chief Technical Officer, Gas Light and Coke Company)

About one-half of the domestic fuel requirements of the nation are fulfilled by bituminous coal used at very low efficiency. The substitution of gas at present prices would represent to the user nearly 50 per cent. increase in cost if no allowance be made for added convenience, cleanliness and labour-saving. Substitution of gas and coke in the proportions as now produced by the Gas Industry represents no increase in cost to the user and many advantages both to the user and to the community. To meet this demand more than double the present output of gas and coke will be required, an estimate still further to be increased with improving standard of living. Large-scale and industrial uses of gas should also show substantial increase, though to a much greater extent depending upon the industrial prosperity of the nation.

Off-peak current will be an effective competitor with gas for heating to the limit of its availability, which will be conditioned by the size of the lighting peak, and it is difficult to see, for many years ahead, the use of electricity in the home approaching even 10 per cent. of domestic heat requirements. Exploitation by the electrical supply undertakings of a virtual monopoly of current for certain purposes by the inflation of charges to subsidize uneconomic loads will increasingly become subject matter for effective protest.

The production and distribution of between two and three times the present output of gas must involve some increase at time of peak demand which will present sufficient problems to the gas engineer without anticipating an era of complete gasification requiring more than double that expansion to fulfil all potential demands. The rate of expansion of the use of gas cannot be forecast with certainty. The average increased demand for gas service per head of the population for the last ten years has exceeded 2 per cent., and for the population as a whole has been about 2½ per cent. In the years to come stabilization of the efficiency of gas appliances will require that these increased demands for service be wholly fulfilled by increased sales of gas. Improved standards of living and enterprise on the part of the Gas Industry itself may easily accelerate this rate of increase to 5 per cent. or more per annum.

Gas Quality.

Reliability.

The future will show no demand from the community for gas as a commodity, but an increasing demand for the service which gas can give. The first criterion in any service must be reliability. It will no longer be a sufficient claim on the part of the Gas Industry that the supply of gas never ceases; it will be necessary to ensure that the service, whether it be in terms of cooking, room heat-

ing, water heating, or industrial processes, never fails in quantity or in quality. This change in public mind in viewing gas no longer as a commodity, but as a service, is to be welcomed, but its profound effects have yet to be appreciated by the Gas Industry as a whole. Fundamentally, the design of any gas appliance derives from the essential characteristics of gas as a fuel, and the future of gas appliance design must depend ultimately upon the characteristics of the gas which is supplied in the future. For a perfect heat service there are two main requirements: it must be available when required, and it must be in the form required.

Purification.

A few years ago the presence of naphthalene rendered the continuous supply of gas almost a haphazard affair. To a lesser but real extent the presence of water and rust has a similar effect. The engineers responsible for gas manufacture have tackled these problems, and in many parts of the country the removal of naphthalene and water and the subsequent clearance of rust deposits from the pipes have overcome uncertainties of supply under these heads. Unfortunately, in some cases these improvements have not achieved 100 per cent. reliability in supply owing to their having been followed by the formation of gum which has deposited in the appliances, gradually throwing them out of action. The factors contributing to the formation of gum are, however, now well understood and the eradication of this nuisance can be anticipated with confidence.

During recent years the presence of sulphur in gas has been recognized as a substantial handicap to progress as accelerating corrosion in appliances, as predisposing towards condensation and as liable to be objectionable where, as is most frequently the case, gas is used fluelessly. The technical methods for the reduction or removal of sulphur from gas are well understood and the economics recognized as practicable. It is to be anticipated that gas of the future will not exceed a sulphur content of 10 grains per 100 cu.ft. or less.

Calorific Value.

The declaration of calorific value in any particular area was a fundamental step forward towards the provision of a gas service reliable in quality. Between statutory requirements on the one hand and economic considerations on the other, the calorific value on the area of any one Gas Undertaking is approximately standard, but wide variations exist between the calorific values in different Undertakings. These variations are often said to be justified by economic considerations of the plant in operation and of the coke market available. In view of the simplification in gas appliance design and the improvements which would be made possible in gas service by a standardization in calorific value throughout the country, it is regrettable that since the Gas Regulation Act, 1920, there has been so little evidence of working towards a single standard for the whole country. The average calorific value at the present time is about 475 B.Th.U. per cu.ft., substantial amounts of gas being distributed at values between 400 and 560. If it be felt that the very small increase cost per therm which might be involved in a change to a national standard value would seriously handicap the sale of gas, the acceptance of a limited number of standard values would remain a practical alternative and would be of fundamental benefit both to the consumer and appliance manufacturer and to the Gas Undertakings themselves.

Combustion Characteristics.

Calorific value is not, however, the only criterion of the combustion characteristics of a gas. Two gases of the same calorific value may require on gas appliances quite different adjustment. There is as yet no recognized standard whereby these combustion characteristics may be measured, consisting as they do of the joint effect of specific gravity and flame velocity. Change in specific gravity will modify both the gas rate and the degree of aeration, while change in flame velocity will affect the flame shape and flame stability. On any burner, aerated or otherwise, excessive gas rate due to low specific gravity may lead to incomplete combustion, while inadequate gas rate due to high specific gravity may lead to inadequate heat output. On non-aerated burners, change in gas quality may lead to flame contact and so to sooting or incomplete combustion, while on aerated burners high specific gravity may lead to over-aeration and lighting back, which may also be brought about by increase in flame velocity even with gases of the same specific gravity.

That these inconveniences have not previously been more vividly realized has been due to the relatively low standard expected by the community for gas appliances in the past. This has reconciled the consumer to making adjustments himself, with which in the future he will no longer be prepared to be bothered. In recent years the increasing demand for coke has led, if anything, to the production of gas of decreasing specific gravity which has disguised changes in flame velocity, since the chief effect has been a tendency to increase gas rate and decrease aeration. Any reversal of the process whereby the specific gravity or flame velocity of gas is increased is likely to lead to considerable trouble, due to lighting back of appliances set to accommodate present conditions, and it is unlikely that these lighting back troubles will be happily accepted at the present time by consumers who have been encouraged to expect a trouble-free service. Some limit will therefore require to be put to the permissible range in variation of gas quality within the area of each Gas Undertaking.

Future Developments.

The multiplicity of these various requirements may seem extravagant in view of the long history of the Gas Industry, unprovided with these refinements. They are, however, essential if the consumer is to be offered the reliable heat service he demands and which, with enterprise and goodwill on the part of the Industry, gas is in a unique position to provide.

Without considering the stages whereby it may be reached, it is of interest to consider a future gas supply and quality which shall be ideal and in the expectation of which the general direction of gas appliance design shall progress. By the adoption of a standard calorific value and gas quality throughout the country or by the adoption of a limited number of standards to be applied throughout the country, gas appliances need no longer be provided with adjustments, but can be issued from the manufacturers all ready and finally set for the gas with which they are to be used. Installation will involve only connecting up to the existing gas supply, as is the case with electric appliances, while maintenance will not involve the need for burner readjustments. Meanwhile, progress in burner design and the use of governed pressures will have been such as to give a maximum of latitude to the range of calorific value and gas quality to be observed. The lower the calorific value (or, alternatively, the higher the pressure), the greater the latitude in burner performance owing to the greater proportion of the air required for combustion which can be entrained at the injector without instability of flame.

Gas Control.

Uncertainties in gas appliance performance and adjustment no longer acceptable to the consumer are created by variations in pressure. With increasing demand for gas, the distribution engineer will have a sufficient problem to ensure adequate pressure without also being required to guarantee its constancy, which can more economically and reliably be maintained by governors on consumers' premises.

Governors.

The use of governors will undoubtedly become universal (*cf.* Australia) by reason of the higher standard of reliability and greater output of heat service demanded by the Public, and partly by the greater precision of setting required by modern gas appliances. Experience shows that the initial cost of governors is often more than offset by servicing economies following their use. Whether the governors shall be of the pressure or volume type attached to each appliance or whether they shall be of the service type, with the renewal of the house carcase where this is inadequate, it is too early to prophesy. It may be, in the long run, that to supply the community with two or three times the amount of gas it is at present using will require a much greater use of high pressure distribution systems, with the necessity for using service governors on every house, quite apart from the desirability of maintaining a standard pressure on each appliance.

Gas Taps.

The direct control of gas appliances by the gas tap is so familiar that the unique advantages of this simple device have almost been forgotten, and far too little attention has latterly been paid to its design and manufacture. Much inconvenience is caused to the consumer and expense to the Industry by the maintenance required to be given to the millions of gas taps now in operation in consumers' houses. Taps rely for their operation, if not for their soundness, upon a film of lubricant, the sealing parts of the tap often being kept in very indefinite relation to each

other. If not operated for a prolonged period of time, or if exposed to high temperature, the moving parts are likely to stick or leakage may develop—weaknesses which could undoubtedly be overcome, as in some directions they have been, by giving adequate attention to the mechanical and physical requirements. Standardized spring washers, modified cone angles, modified gas ways, and, possibly, the use of self-lubricating metal, all appear practical developments. On some appliances improvements in tap design are overdue to facilitate gas rate control and allow a maximum angular movement of the plug over the range of gas rates which in practice is desired.

Gas taps and other gas controls which are visible to the consumer deserve greater care being devoted to their appearance, without their function being necessarily so disguised as to make their method of operation in any way obscure. Various simple varieties of safety taps will increasingly be used, and in some cases special economy controls will probably become available to prevent undue wastage of gas, such as a protruding knob on the cooker hotplate which will allow full gas rate to pass to the boiling burner only when a pot is in position.

Time Controls.

Except on public lamps, time controls in association with gas appliances have scarcely been available to the public, although in quantity they can be produced at low price, and would appear to have many simple applications, such as limiting the time of operation of gas ignition to a coke or coal fire, putting a period to the time a bath heater or gas fire is in operation, or controlling the preparation of toast.

Remote Controls.

The remote control of gas appliances other than lighting burners, so that, for instance, the gas fire can be turned on or off from the door, has been slow in development, nor can it be certain that there is a popular demand sufficient to justify the development of such a fitting. The remote control thermostat, however, will be increasingly used.

Thermostats.

Direct acting thermostats are familiar on most appliances where their presence can contribute to more automatic operation, but have yet to be combined with an indication that the heating operation, such as cooking, with which they are associated, has reached completion. Appropriate choice has not always been made in the past between snap action and gradual action types.

Automatic Ignition.

The last few years have seen widespread developments in automatic or semi-automatic ignition of gas, a convenience to the consumer, and encouraging a more generous use of the appliance. This has been accomplished by the use of mechanically operated spark mechanism, by catalytic wire preheated electrically, or by catalytic wire preheated by active catalytic pellet. The latter is the only type truly automatic and independent of any manual operation, but as yet the pellets cannot be relied upon indefinitely to remain active nor to ignite the gas without the possibility of a few seconds' delay. Further improvements, together with the availability of this type of ignition in conjunction with a thermo cut-off to prevent accumulations of gas prior to ignition, are likely to lead to its more universal adoption. The thermo cut-off itself in conjunction with a pilot light is now familiar, and is increasingly being adopted on appliances where, in its absence, explosion may take place and where the few seconds required for its operation are not a substantial disadvantage. Improved pilots of greater stability and lower gas rate will displace present types.

Gas Burner Design.

In the absence of flame contact and where the combustion space is adequate in size, there is little justification for the use of the aerated burner. Flame contact, however, is very often desirable in the interests of rapid heat transfer calling for some form of aerated flame.

Burner design is capable of considerable improvement in the direction of silence and stability. Self-righting aerated burners, which at full gas rate are incapable of lighting back and which will restore the flame to the burner head if lighted at the injector, have been commercially available on the Continent for some years. Where it has been desired to reduce the gas rate to below one-tenth of its normal value it has hitherto been necessary to employ a double burner and duplex type of control, but a closer enquiry into the physics of burner design may lead to a greater flexibility of gas rate without this extra complication, if only by the automatic increase of head resistance in the burner as the gas rate is reduced. Aeration control is variously operated by control of pressure, of injector size, of air ports, of burner resistance, and of head resistance. Rationalization of these various types of control for various purposes will be superseded by fixed controls as and when gas qualities and pressures themselves are standardized, so avoiding the possibility of any maladjustment in use, since no regulators will have been provided. Pending completion of this change, gas rate adjustments will increasingly be carried out not by checking against the meter, but by the use of the pressure gauge, ensuring twice the accuracy in half the time. This requires the provision of a pressure point on the appliance.

Finality can scarcely yet have been reached in the design of the gas aeration device, which at the present time appears to have a mechanical efficiency of under 5 per cent., a fraction of the theoretical limit. Complete air requirements cannot normally be provided as primary air, except by the use of high-pressure or mixture gas. Even on the injector principle sufficiently high efficiencies for this purpose are theoretically possible, and would find many applications. The higher the injector pressure or the lower the calorific value the simpler becomes the solution of this problem. In the alternative, where theoretical aeration is essential, other methods with a higher efficiency than injector action may be adopted, although generally speaking they will be more cumbersome.

FUTURE OF DOMESTIC GAS APPLIANCES.

Beyond the fact that appliances will be more and more critically examined by the user in relation to the home in which they are to be installed, it is impossible to forecast the direction in which the appearance of domestic gas appliances of the future will advance. Advantage will require to be taken of new materials and new finishes, subject to change in fashion and the functional requirements of the appliances themselves. In contrast to the past, when gas appliances have been in the nature of additions to the home, they will in the future require to an increasing extent to be a part of the home.

The need for general room ventilation or the high gas rate of the appliance have led to the use of flues in connection with 10 to 15 per cent. of the total amount of gas used for domestic purposes. Such flues lead to extra expense and often involve negotiations with landlords, architects and Local Authorities. These difficulties favour development in the direction of flueless appliances, the controlling limitations of which are now better understood and will be relaxed with better quality gas.

Improvements in appearance and technical performance may involve additions to the cost of production, though this is not inevitable. Often by simplifying installation and maintenance there may be a direct saving to the Gas Undertaking and so to the consumer. Experience suggests that the introduction of hire-purchase terms reduces the price difference between appliances to such small sums on each instalment as to popularize the better and more expensive appliance at the expense of the inferior and cheaper article.

For some purposes, such as hot water service, central heating, and refrigeration, a fixed weekly all-in charge has been offered in place of charging for gas by meter. The consumer knows his commitments at the outset and, despite its slow development, such a system for selected purposes may become more popular in the future, avoiding creation of doubt as to whether all the gas used at low gas rates is fully registered by the meter.

Where the displacement of the use of raw coal in the home can be better achieved by introducing gas and coke rather than gas alone, combined appliances involving the use of both fuels may have a field. In the light of experience that double purpose tools are rarely a success, the appliances for gas and coke may be physically independent, but their introduction and the subsequent supply of the two fuels may be effected on a combined contract.

Water Heating.

It is doubtful if gas supplies more than 20 per cent. of the present domestic hot water requirements of the country, themselves a fraction of the potential demand. Of this proportion, more than one-half is probably by the use of the kettle, and much of the balance by some form of single-point appliance. Yet, by reason of its flexibility and controllability, gas appears destined to provide the ideal trouble-free hot water service to the home. Development of this load has been slow—due less to absence of satisfactory appliances than to indifferent salesmanship and installation. Appliances unsuitable for requirements have been

installed, and unlagged systems on gas circulators have established the tradition that a full hot water service on gas is prohibitive in running cost. A large capacity storage set continuously in operation to serve the week-end needs of a small flat or cottage is as likely to result in well-merited complaint, as is the provision of a small-sized geyser in a house in Mayfair, although each system may be precisely appropriate for the reverse situation.

A wide variety of water heating appliances is available, and new design developments are likely to be in the direction of refinement of these, and especially in increased reliability and reduced need for maintenance, rather than in the exploitation of any novel principle. A possible innovation would be the design of a simple gas conversion set for the domestic coke boiler or on the storage tank or flow pipe preferably arranged to allow coke or gas to be used by the consumer at will. The apparent simplicity of installation of such a device, compared with an independent gas circulator used with or without a flue and connected to the existing system, may be more than offset by other difficulties in practice. Because the coke boiler is in the kitchen or scullery, the same room does not necessarily provide the ideal site for the circulator, the most economical position for which is more often dictated by the position of the tank or cylinder it is to serve. Where the tank or cylinder is of large capacity it may sometimes be preferable to connect the return to the circulator well above the bottom of the storage and so limit its hot water capacity when operating on gas. The installation of a gas circulator on an existing satisfactory coke boiler system leaves the coke boiler available for use in the winter, when warmth is required in the kitchen, and usable throughout the year for the burning of rubbish. To an increasing extent the gas circulator in modified design is also likely to be used for boosting the temperature of the water when the supply from the coke boiler is inadequate.

The total displacement of coke as a fuel for domestic water heating is not necessarily a wise policy for the Gas Industry which, with rising gas production, may find increasing difficulty in obtaining an outlet for the corresponding increase in quantity of coke produced. For this reason and apart from a large number of situations where the single-point gas water heater may form a most useful auxiliary to other methods of preparing hot water, the two unsatisfied markets for gas as the sole means of providing hot water in the home appear likely to be at either end of the income scale of the consumer. The factors ensuring successful development of these two markets appear respectively to be utmost economy for the working-class home as yet unprovided with hot tap supply and ideal reliability and convenience for the relatively well-to-do, whose service hitherto may have been inadequate, even though expensive.

In the small home, where economy is vital, baths are a weekly rather than a daily event, and the bulk of the hot water requirements will be for small quantities for sink and washing purposes. The user will put economy before convenience, and will be prepared, if necessary, to light the appliance prior to drawing hot water. The wash boiler for the preparation of bath water, in conjunction with the kettle on the hotplate for smaller quantities, represents the most primitive type of this service. The small multi-point instantaneous heater, preferably connected by small piping to small taps, has successfully fulfilled requirements or, alternatively, the small single-point heater for sink and large single-point heater for bath may be installed if the capital costs are not prohibitive. The single-point bath heater lighted for the occasion can be, with equal economy, of the instantaneous or storage type. A big factor in economy in such situations is that the bath and basin should themselves be of the smallest practicable size, while the hot water supply should not be so abundant as to encourage waste. One of the factors significant of an increased standard of living is a more generous use of hot water in the home, and the future field for gas for this purpose is likely, with an increase in the standard of living, to be very much wider than present domestic hot water requirements suggest.

For the well-to-do the ideal hot water service would be one in which the pressing of a button or the manipulation of a handle would fill the bath or basin with hot water in a few seconds at the required temperature. Gas can provide this service. In a large establishment it may be desirable not to operate from a single appliance connected to long runs of lagged pipe, but to capitalize the fact that no heat loss takes place from gas pipes, and to sectionalize the system using several heaters—even single-point heaters of some automatic design—in isolated positions.

Existing water heaters may be divided broadly into storage and non-storage types. Desirable refinements confidently expected include improved facilities for maintenance and, by the use of new materials, rational design and decreased sulphur in the gas, less need for maintenance either to the flueways or waterways. Scaling of waterways may be virtually prevented by a calorifier system, the additional cost of which may be justified in areas having very hard water. Corrosion of the waterways remains in some localities a problem capable of solution only by the use of resistant materials or finishes. The non-storage or instantaneous type will be increased in capacity and improved in its controls so as more nearly to give the abundant flow of hot water at the required temperature characteristic of the thermostatically controlled storage type. It is doubtful, however, if it can equal the storage type for ideal service, and equally doubtful if the peak demand it might create if used universally would be acceptable to the distribution engineer.

The inconvenience of arranging for flues will often favour the small single-point heater or small circulator so positioned as to be able to be used fluelessly. It is possible at the other extreme that the " balanced flue " principle may establish itself as an acceptable means for rendering the larger appliances quite independent of wind effects.

Special purpose hot water appliances have been developed and will be further perfected for the preparation of boiling water for tea-making and the like and for the preparation of high-temperature water for dental and surgical purposes. In the absence of water softening plant these types of appliances require especially easy access for descaling purposes, or may, in some cases, be of the instantaneous type in which the water comes in direct contact with the products of combustion.

A development for the future, greatly overdue, is the availability of a satisfactory dish-washing machine for the home the hot water for which, being required at pre-determined temperatures, can best be heated by gas.

Home Laundry.

In contrast to the U.S.A., where gas wash boilers are scarcely known and gas irons are non-existent, the use in our country of these appliances and of washing machines shows steady development. The higher efficiency type of wash boiler (and washing machine) will be further developed, not only in the interests of low running costs, but for speed of operation—a factor which can be still further improved if a flue is used and if, in installing the wash boiler, facilities are provided for filling it with preheated water. The smaller wash boiler, capable of standing on the table and of being more easily moved than the standard type, may achieve popularity.

Gas irons are of two types, one served by flexible tubing, the other heated over an independent burner. Hitherto, the former has been the more popular, possibly due to lower price, although undoubtedly it is less easy to operate. It is, however, capable of being fitted with a manual or thermostatic temperature control.

Gas drying cabinets have hitherto found limited use in the home, but may be further developed. The drying process depends more upon air flow over and through the wet fabrics than upon the rise in temperature. Inadequate air movement with high temperature may lead to felting of the fabrics. Various developments in gas drying devices are at present active, and may lead to interesting results.

A gas airing cupboard unit has long been available, and, with increase in popularity of the non-storage type water heater, may be used to a greater extent than hitherto.

Space Heating.

At the present time gas probably supplies less than 5 per cent. of the room heating requirements of the country, and in the bulk of households finds application only in the form of one or more gas fires intermittently used. Much research work has been carried out in this country and overseas on the conditions to be provided in a room to ensure ideal comfort to its occupants. Many new types of heating have been developed which can now be served by gas, and the future should hold many changes and new developments in gas appliances for room and house heating purposes.

In view of the insistence of the hygiene authorities upon the necessity for adequate ventilation, it is doubtful whether the tendency in modern buildings to dispense with flues will for long be allowed to continue. In conjunction with a flue a gas fire is a double purpose apparatus, providing positive ventilation as well as high temperature radiant heating. With a minimum size of gas fire flue and with the normal type of gas fire, two or three air changes per hour are ensured, and up to three times this degree of ventilation where the inset type fire is used in conjunction with a full 9 in. by 9 in. flue. The higher efficiency gas fire, giving greater heat output per unit of width and a shorter wavelength radiation leading to less scorching of the skin, has been developed by decreasing the heat losses through the firebrick back and by closer attention to the

form and fit of the radiants. The radiating surfaces have thus been brought to a higher temperature without prejudice to good combustion, but it is doubtful whether much further progress in this direction is commercially possible. The popularity of the gas fire as a means of continuous rather than intermittent heating will require ability of the fire to be turned down to a reduced gas rate and reduced heat input to the room without prejudice to the appearance of the radiants. Since the bright appearance depends not upon the total heat output, but upon the incandescence of small points of refractory within the radiant, this flexibility in heat output without substantial change in appearance can theoretically be obtained and will shortly be commercially available. Such a development will enable a single size of fire to be used in a wider variety of situations than has hitherto been possible. The radiants themselves remain vulnerable to breakage, and in due time unbreakable radiants will be developed of acceptable appearance when cold. Devices may be introduced to enable the user to vary the distribution of radiant heat at will.

The gas fire or any other heater from which the output is wholly in the form of radiation is a system of heating which is not always ideal, since a proper balance requires to be preserved between the radiant heat received by the occupants of the room and the temperature of the air in the room. On the Continent gas fires have for long been familiar in which the radiant heating is combined with the provision of a heat exchanger in order to warm the room air, while in the U.S.A. gas fires are frequently used fluelessly and so achieve the same end.

In this country the heat exchanger as part of the gas fire has not yet achieved any considerable popularity, but this development may grow with or without thermostatic control. Alternatively, fires may be provided with some means for passing into the room a small quantity of the products of combustion themselves with their associated heat. The fire itself is not, however, necessarily positioned ideally for this purpose, and small independent flueless heaters, each burning 4 or 5 cu.ft. per hour, may with great advantage be used. They should preferably be placed near each window, giving a total gas consumption of about 4 cu.ft. per 1,000 cu.ft. of room space. The small gas rate enables the supply to these units to be carried out in small diameter tubing at low cost. There is no hygienic or other disadvantage to the flueless use of gas in this fashion, and the increased comfort provided to the occupants of the room will undoubtedly ensure for this form of background heating considerable popularity. The use of flueless heaters of higher gas rate in halls and passages for raising the temperature of the air 10 to 15° F. has long been familiar, but the use of smaller units in the rooms themselves has not hitherto been developed. The heating provided, being at 90 per cent. efficiency, will be at lower cost than the use of coal, while economy and comfort can be further ensured by putting these heaters under the automatic control of a room thermostat. With the halls, passages and rooms so heated, the householder will receive at low price all the benefits of low temperature central heating, the rooms being provided with gas fires or other forms of heating to ensure the necessary "topping up" and ventilation. Unlike most forms of central heating the heater will require only to be turned on or lighted at the beginning of the autumn and to be turned out late in the spring. No longer will the occupants draw nearer and nearer in cold weather to whatever fire be provided in the vain hope of warming their backs, since the radiant heat received will be sufficient at the higher air temperature to ensure complete comfort in any part of the room.

Whereas the background heating units for rooms are expected to be inconspicuous and solely for air heating purposes, the units used in halls and passages can often with advantage produce a proportion of visible or invisible radiant heat. In any case, precautions will be required to prevent the temperature gradient between the warmed air and cooler wall causing deposition of dirt and to avoid excessive temperatures on the surfaces of the heaters themselves.

Gas is likely to be used to an increasing extent in modern building construction unprovided with flues, where the background heating of conventional type may already have been provided and where some "topping up" and a cheerful focus in the room is required. Units have been introduced at low gas rate but of bright appearance which can be used fluelessly in a semi-permanent construction similar to a conventional fireplace.

In small bedrooms, although gas fires are often installed, their use is scarcely possible owing to the close proximity of the bed or other furniture. In such situations, there appears wider scope for the small radiant heater positioned several feet above the floor, the heat being directed downwards on to the occupants of the room. A similar type heater, used with or without a flue, would also often be of advantage in the bathroom. A disused lighting point will often form a convenient connection.

For complete central heating the gas boiler connected to conventional heating systems serving radiators, panels or pipes built into the fabric will find increasing use in the larger homes where direct gas-fired high or low temperature panels or air heaters (such as are used in shops, factories, &c.) are inappropriate.

An efficiency higher than 100 per cent. and much higher than that of any central heating boiler can be obtained by the use of a gas engine the waste heat from which is absorbed in the water circulation, itself preheated by a reversed refrigerator operated by the gas engine. The capital costs, however, would perhaps usually more than offset the lowered fuel cost.

Cooking.

The majority of homes in this country use gas for cooking and cookers represent more than one-half the output of gas appliances from the manufacturers. More attention in this country has been paid to their design than to that of any other gas appliance.

There will probably long remain a demand for cookers following the conventional arrangement of a hotplate about 3 ft. from the floor carrying several boiling burners with the grill positioned between it and the oven. Such an arrangement is not perfect for convenience in operation but is probably the best compromise consistent with a narrow width. Overseas, especially in the U.S.A., the wider cooker or range with two ovens or oven and hot closet side by side has become more popular than in this country where, among other reasons, the continued presence in the kitchen of the obsolete coal range leads to inadequate space for the gas cooker. The development of the art of kitchen planning appears likely to create an increasing demand for the gas range or for cookers built on a unit principle which will allow the different components to be arranged rationally in each kitchen according to their special function and the operating lay-out of the working space.

The hotplate is responsible for the bulk of the gas used on the cooker. The rate of heat transfer from the flame per unit of area of the vessel is higher on the boiling burner than in most other applications of gas. Even so, the limits have probably not yet been reached and further work is active to speed up boiling operations still further. Flame contact, which is virtually essential for high speed operation, is undesirable in simmering if local burning is to be avoided on thin base vessels. Special vessels having ribbed bases to speed up heat transfer will increasingly be used, these not suffering the deterioration characteristic of the more expensive vessels required for the electric cooker.

Although various forms of semi-automatic lighter on flexible tube are familiar, very few cookers in this country have followed the almost universal practice in the U.S.A. in providing automatic ignition on the hotplate. In its simplest arrangement this can take the form of a low consumption pilot light provided to the burner most commonly used, or either spark or catalytic ignition at the injector of a self-righting burner.

Few hotplates at present are attractive in appearance when new, owing to the exposure to view of the burner shanks and supports beneath the hotplate bars, while the appearance of the latter after a short period of use is usually unsatisfactory. Trays beneath the burner heads and improved finishes or materials for the top hotplate surface will develop. There is undoubtedly a potential if limited demand for a hotplate consisting of virtually continuous flat plates (as in some modern restaurant cookers) through which the heat is conducted to the vessels, even though the improvement in appearance and cleanliness is obtained at some sacrifice to efficiency and extra heat into the kitchen.

The use of light metal frets on the griller and correct relation between fret and flame enables quicker heating up and more adequate grilling to be obtained. The expense of heat resisting metal will often justify on grounds of economy the use of a single fret with a double burner instead of the reverse arrangement, which is normally the cheaper. A solid plate over the grill further increases its efficiency and prevents dirt falling onto the fret while the plate itself, brought up to the hotplate level, may be used for simmering purposes. Raising the level of the grill enables the oven to be correspondingly raised with advantage. With the grill absent altogether from this position, cooker design is simplified, appearance improved and the oven rendered more accessible. Some consumers never use the grill, others use it only for toasting. If cookers be developed without normally positioned grillers, independent domestic grills and toasters will be required. The

former could be positioned in place of the platerack and act also as a hot closet (light weight types of the latter are now sometimes used in this position). The toaster in vertical form could be portable or constructed in the splash plate, as on some American cookers.

Cooking in the oven can probably be still further simplified and the initial heating-up period reduced. Roasting and baking are complex physical and chemical processes depending not only upon the temperature of the gases in the oven and their humidity but also upon the temperature and character of the surrounding linings and the heat capacity of the internal oven fittings. In the perfect oven, the heating-up period would be short at high gas rate and the heat capacity of the oven itself just sufficient to prevent the introduction of the maximum load excessively reducing the oven temperature. The bulk of the heat loss from the cooker is not through the flue, as is commonly assumed, but through the lagging, which will be further improved. The flue will be so arranged as to ensure a minimum passage of air and an appropriate humidity in the oven. Wall staining behind the cooker has been greatly diminished by the introduction of the bottom flue outlet, but terminating the oven flue at about hotplate level and directing it towards the hotplate may be found to have further advantages. Oven cooking characteristics will require to follow changing requirements in different parts of the country, some cooks preferring equi-temperature ovens while others find advantage in a gradient of temperature from shelf to shelf. Thermostats will become universal and will be modified in type and position, and may directly indicate completion of the heating-up and cooking periods. Oven linings will be made detachable for ease in cleaning. Glass doors on ovens are familiar but their popularity appears limited.

Apart from the full-scale cooker in the full-scale kitchen the miniature cooker will increasingly be required so long as flat construction provides only an enlarged cupboard for all kitchen purposes. The space provided and the requirements of the flat dweller will justify only limited cooking facilities, scarcely more than is necessary for the preparation of breakfasts and the like, the cooker being closely associated with the refrigerator, which acts as the only larder.

At the other extreme is the household which has entered into a contract for an electric cooker and finds the service inadequate or the running cost prohibitive yet cannot legally displace the cooker under a period of years. In many such cases experience shows a lively demand for a gas hotplate which can be used on top of the electric cooker.

These considerations of cooker design of the future have assumed that, while the cooker will become a more integral part of the kitchen lay-out it yet remains a general purpose appliance, leaving to the user's judgment the manner of performing various operations with such utensils as are available. In other directions specialization is so much the vogue that the gas cooker may well follow suit and be designed upon specialist lines. The chop, stew, vegetables, fish, roast or sweet, each inserted in the appropriate compartment, could automatically be given by gas the appropriate heat treatment. No separate utensils would be used, all would be components of the cooking machine. At most the specialized processes would extend to about eight: boiling, simmering, frying, deep fat frying, grilling, roasting, slow oven and hot closet. Labour-saving, economy, a cool kitchen, speed and perfection of result would all be served by such a cooker design, the high capital cost of which would not necessarily be a deterrent as has been shown by solid fuel storage cookers.

Miscellaneous.

Water heating, home laundry, space heating and cooking are the applications of fuel in the home which may be looked upon as necessities. Beyond these four uses there are other directions in which heat in the home can be a convenience. The use of gas in flueless appliances for heating the garage or greenhouse has scarcely yet been developed, and where this heating is not carried out by some relatively expensive indirect system, paraffin (or very occasionally electricity) is commonly used. The higher price of gas compared with paraffin is more than offset by its greater flexibility and cleanliness, and provided the sulphur content of gas does not exceed 20 grains per 100 cu.ft., no difficulties due to the products of combustion compared with paraffin can arise. In the case of garage heating, the gas flame requires to be protected with gauzes and, where economy is a vital consideration, the unit is best designed a few inches high only and positioned on the floor of the garage beneath the bonnet position of the car.

The independent towel rail, cigarette lighter, clinical lamp, Turkish bath and tropical fish tank are examples among the many extra applications of gas in the home of prestige or novelty value which may show development. The popularization of the gas refrigerator during the last few years to a stage of appreciable load demonstrates what can be done even with competitive specialities.

Gas also has application in the garden as a stimulant to the bonfire and in garden or house for the incineration of household refuse. Even wet refuse is of sufficient calorific value to evaporate all the water it contains but slow distillation of this contained water creates nuisance by smell and a high temperature combustion space for the ignition of this rubbish is desirable.

The gas poker has long been familiar and is achieving increased popularity, while gas ignition with coke fires is well-known. Such ignition can be effected as easily by properly positioned luminous jets as by aerated burners, and can be applied equally to nearly all types of coal fires by the insertion of a gas supply through the cheek above or below the fire bars. Whether lighted by match or automatically this ignition, which represents a good gas load, will achieve greater popularity in the future.

Lighting by gas is thermally an inefficient process but remains, for the poor at least, a satisfactory if less fashionable alternative to electric lighting, which is available often only at inflated prices. Switch control places gas for lighting on a level with electricity on the score of convenience, and in many situations the background heat which is developed by the gas is a direct advantage and economy. Where gas is displaced for lighting there is a heating load for gas to be gained. Lighting fittings and switches are increasingly being provided free or on specially favourable terms. It is to be hoped that greater diffusion of the hot products will be obtained by improved design of gallery (or a higher lighting efficiency) to diminish the deposit of dirt on adjacent surfaces. The installation in hundreds of thousands of homes of plug-in connectors for various purposes should facilitate the introduction of floor standard and table standard gas lamps, against which the disadvantage of dirt deposition cannot be advanced.

Both in the necessity and auxiliary class gas appliances vary very widely indeed in their capital cost in relation to the value of gas they will use. In some cases their cost represents several times the value of the gas they will consume during their whole life; in others in a single year they may use gas to an extent much greater than the capital they represent. In these days of hire-purchase an increasing number of homes find little balance available even to meet the gas bill and this difficulty is increased and economies in gas are enforced if heavy instalments are due on appliances. The Gas Industry will be well advised to help the consumer to make a wise choice in his gas appliances in the home in relation to the family budget for a share in which there is such a multitude of insistent competitors.

FUTURE OF LARGE-SCALE AND INDUSTRIAL GAS APPLIANCES.

Cooking.

Many large-scale applications of gas are in parallel with uses in the home, but with some modification in size and detail of design. Leading restaurants, clubs and hotels use gas for cooking, the cookers having embodied in their construction many features originally developed for domestic use. Vitreous enamel, thermostatically controlled ovens, unit constructions, enclosed hotplates with hot spot, and improved grillers are all familiar and will progress, subject to a high and reliable quality of cooking being attainable such as to offset alternative cheaper if less flexible fuels which may at first analysis appear more economic on large-scale use. The fuel bill is an extremely small item in comparison with the satisfaction of the customer and of the chef. Gas, too, finds application in fish frying, a highly competitive market capable of being retained and extended only by maintaining continued improvement in the future as in the past.

The baking engineers have recently been turning their attention to the use of gas for bread baking and developments are rapidly taking place. One manufacturer has been able to reduce the consumption for an equal load by 50 per cent. by considering the heat transmission problems involved. Service can often be rendered to the small baker and the Gas Industry alike by the conversion of existing solid fuel fired ovens to use gas, as a first step towards the use of modern ovens primarily designed to operate on gas.

Space Heating.

Large-scale space heating in shop, hall and factory, and even Turkish baths, is responsible for an increasing use of gas, especially as the potentialities of the direct gas-fired

radiant panel and air heater become better known. The radiant panel with its ability quickly to create comfort conditions is particularly of value where occupation is intermittent. Air conditioning for climatic reasons has been more acceptable in the U.S.A. than in this country but may become more widely used, provided the fashion be created. A practical and economic advantage of air washing accompanying its conditioning is the reduced amount of cleaning necessary, owing to the decreased amount of dust introduced into the premises. Gas has been used both for warming the air and for its humidification (and in the U.S.A. for its de-humidification). Perfect control and the ease with which the system using gas can be sectionalized, both commend this fuel for the purpose.

Lighting.

The technique of gas lighting in factories, schools, shops, &c., is controlled by the same factors as the use of gas for lighting in the home. For street lighting other factors operate and changing technique of street lighting will affect the type of lamps to be provided, requiring greater output of light, improved methods of control and different light distribution. The future alone will show whether the present fashion for the use in main thoroughfares of very powerful light sources at wide spacing and high mounting will persist or whether closer spacing and less powerful units will in the long run be found preferable.

Industrial Processes.

Gas is uniquely able to provide commercially controlled temperatures up to about 1,500° C., or for special purposes up to nearly 2,000° C., and atmospheres either inert, oxidizing or reducing. During the last few years progress has been especially rapid in the development of large-scale gas appliances suitable from every point of view for installation in the most modern restaurant or factory. To an even greater extent than in the home cost determines the fuel to be used in an industrial or trade process, cost being judged not on gross or net heat values alone but on throughput, wastage and quality of material produced. The rapid rate of advance of gas in this field, characteristic of the last few years, is unlikely to decrease, and the field represents a demand for heat many times the domestic demand.

Pan heating, whether at relatively low temperatures for sweets or oil or at high temperatures for metal melting, requires continual attention to development to ensure maximum heat transfer and the use of materials which will remain inert both to the flame and to the contents. The immersion heater, in which combustion of the gas takes place in tubes beneath the surface of the stereo metal in the pot, has been familiar for some years in the U.S.A. and has been introduced into this country with the possibility of extended applications following in principle the lines of familiar boiler designs.

Stoving and drying processes find gas an appropriate fuel for increased throughput for a wide variety of products. Both intermittent and continuous ovens are used, some of them distinctly prejudicial to a continued use of gas for this purpose, by reason of their casual design and wasteful use of fuel.

Perhaps the most noticeable development of the future in gas oven and furnace design will be the greater application of mechanical devices, such as automatic feed and conveyors, to take full advantage, by accelerated throughput, of standardized conditions which can be assured when gas is the fuel used. The potential heat loss by the thermal capacity of the conveyor mechanism may often justify special recuperation. There is scarcely a limit to the types of processes for which such appliances can be used: carburizing, annealing, re-heating, normalizing, tin printing, core drying, etc.

In some cases it is desirable to exclude the products of combustion from the working space and the muffle then normally used is giving place to radiant tube heating, with higher efficiency and more equal temperatures. The use of gas for vitreous enamelling, for instance, is showing increasing popularity. Many gas-fired furnaces for this purpose are now operating, and the first continuous gas-fired vitreous enamelling furnace in this country has just been erected at Luton.

For metallurgical processes temperature and atmospheric requirements become more and more searching every year, and the so-called "furnace" consisting of an old brick box with perhaps a single burner must give place to an appliance of good appearance, high insulation, and accurate temperature control. Physical characteristics throughout the working space must be understood and planned, since it is not sufficient to assume from single-point pyrometer control that working conditions elsewhere in the furnace are necessarily those desired.

Many processes, such as bright annealing, require a predetermined atmosphere, for the production of which electric furnace designers have for some time been using town gas. The development of suitable gas furnaces for these purposes owes much to the Sheffield Gas Company, and in this field gas should have an assured future.

Where local circumstances enable gas to be supplied at sufficiently low prices, as in Newcastle-upon-Tyne, this fuel finds increasing application in cruder heat processes, such as rolling mills, glass melting, and the like, the scale of which is sufficiently large to justify special design and layout for each individual job. At the other extreme of size, precision small-scale heating apparatus suitable for laboratory purposes enables gas to displace other heating agencies now irrationally used.

The technical principles and devices to be exploited to ensure the continued expansion of the use of gas for large-scale and industrial processes are familiar in domestic appliance design technique. Direct heat transfer from the hot gases or the creation of radiation from incandescent sources, controlled combustion, thermal insulation for high or low temperatures, resistant refractories, governors, thermostats, flue damper control, all these are common throughout gas utilization technique. Special to large-scale technique, though used to a less extent in this country than in Germany and the U.S.A., are high-pressure gas (also for public lighting), air blast or mixture gas when quick heating up, high temperatures or combustion in confined spaces, are required.

It is through the commercial, as much as in the technical sphere, that industrial and large-scale uses of gas can be stimulated in the future. The manufacturer looks to his various suppliers in respect not only of the commodity they supply, but of the degree of assistance they can give him to ensure a profitable return on his operations. His contract for fuel, as for machinery, transport, or constructional work, must bring him technical co-operation on whatever process or trade engages his attention. The Gas Undertaking supplying the gas and responsible for its installation cannot attempt itself to be expert or to employ experts in the thousands of trades and processes to be found perhaps in a single area. The Gas Undertaking, in co-operation with other Undertakings, can appreciate the principles of gas utilization and can co-operate with the specialist industrial appliance manufacturer or consultant to encourage his interest in gas as a fuel in preference to other fuels. In industrial work especially, the Gas Undertaking cannot be self-supporting. The potentialities of gas for future development are scarcely realized, and can be materialized for the benefit of the community and of the Gas Industry only by the whole-hearted co-operation of all concerned.

Consumer Service

Communication No. 159

by
R. N. LeFEVRE
(Officer in Charge of Training, Gas Light and Coke Company)

It is generally agreed that the sale of gas, which, after all, is the ultimate aim of a Gas Undertaking, can only be effected and, what is more important, satisfactorily maintained, by offering to the Public not gas but a service—comfort in the home, efficiency in the factory—which, through the medium of gas appliances, can be obtained in a manner at all times safe, reliable and economical.

The gas appliance is thus the focus of customer satisfaction on which depends the prosperity of the Gas Undertaking.

No matter how good the appliance, however, its efficacy may be completely nullified if it be improperly installed or if the gas supplied be of varying quality.

It would not be an extravagant claim to assert that the whole science of gas engineering revolves around the burner of the appliance. It is here that consumer satisfaction and safety is established or otherwise and, since a Gas Undertaking's prosperity depends upon the satisfaction of its customers, it follows that all branches of its activities are purely means whereby satisfactory appliance performance may be accomplished.

Factors Determining Consumer Service.

A gas appliance will give such satisfaction to the customer that he will continue to use it regularly and thus become a remunerative consumer of gas only if:

(1) It is properly designed and constructed for the purpose for which it is intended.
(2) It is the correct selection for the particular circumstances for which it is required.
(3) The gas quality is controlled and consistently maintained.
(4) The distribution system is carefully controlled.
(5) The appliance is correctly installed.
(6) It is subsequently properly serviced.

Items (3) and (4), though of paramount importance, are outside the scope of the present subject and will be disregarded.

The subject in essence is thus resolved into:—

(*a*) the Appliance.
(*b*) its Installation and Maintenance, which includes:
the Material required,
the Tools and Equipment necessary,
and finally, but, perhaps, most important of all—the Men to do the work.

APPLIANCE APPROVAL FROM THE SERVICE VIEWPOINT.

The testing and approval of gas appliances may be divided into two branches:—

(1) Initial Testing.
This includes all laboratory work connected with design, modification, safety, mechanical construction, appearance, finish, facilities for installation and ease of maintenance.
(2) Routine Testing.
After acceptance and specification a close watch must be maintained on deliveries by means of periodical testing of selected production samples.

It is not the purpose of this Paper to deal in detail with the subject of gas appliance testing as covered under sub-heading (1) above. This subject is adequately treated elsewhere. It is, however, necessary here to review such work in connection with the initial testing of appliances as has a direct bearing on the service organization of the Undertaking.

Experience gained under sub-heading (2) above, in conjunction with a careful analysis of district defects and complaints, is helpful in estimating the possible trouble which may arise or be avoided with an appliance in service.

An appliance passing admirably all laboratory tests for performance, combustion standards, and the like may be so constructed that the fitter finds it almost impossible to connect or the maintenance man has to spend half a day taking it completely apart to reach one small adjustment screw.

Even if it is soundly designed as far as its installation and maintenance are concerned there still remains the problem of how it will behave from the viewpoint of consumer service. Poor finish, taps likely to become loose or stiff, excessive condensation and many other factors will increase service costs and difficulties owing to complaints from consumers in spite of periodical visits for maintenance.

The ideal appliance, assuming it has passed all normal laboratory tests, is one which:

(*a*) *Is easily installed.*
All connections are accessible and standard. Standard tools and equipment only are needed. Fixing arrangements are neat and cheaply effected. Adjustments are avoided where possible but, where necessary, are accessible and simple.

(*b*) *Requires the minimum of maintenance service.*
Attention to design has ensured that flueways, waterways, &c., are adequate. Automatic devices and the like are not likely to fail or get out of order. A reasonable period between maintenance visits is easily determined.

(*c*) *Is readily serviced when maintenance becomes necessary.*
Construction is such that the time taken to gain access to the components requiring cleaning or adjustment is reduced to the minimum possible. Few replacements are necessary (*e.g.*, renewal of washers, gaskets, &c., after disturbance). The complete service may be effected *in situ* without disconnection or removal. Preferably no special tools or equipment are required.

(*d*) *Will give rise to few, if any, interim complaints.*
The maintenance service should suffice to keep the appliance working properly and to be trouble-free to the consumer.

The laboratory personnel responsible for the initial testing of appliances should include someone conversant with district problems. Failing this, a direct link should be maintained between the laboratory and the service staffs to ensure the essential additional features mentioned above not being overlooked at the time of approval and acceptance of an appliance.

APPLIANCE SELECTION IN RELATION TO INDIVIDUAL CONSUMER REQUIREMENTS.

Although partly a sales problem, the question of the selection of the appliance best suited to meet the requirements of any particular consumer or set of conditions on his premises constitutes the *raison d'être* of the gas salesman's training.

Opinion may vary within the Gas Industry as to the degree of technical knowledge necessary for the various types of gas salesman but the fact remains that, were it not for the importance of correct appliance selection, the gas salesman could be entirely devoid of technical knowledge.

The salesman or district representative called upon to decide the best type of appliance to recommend must be able:

(1) To appreciate the many varying conditions which present themselves from the customer requirement point of view; to arrive at the facts, and from these, to select the appliance which without doubt will satisfy these requirements.
(2) To understand fully the technical aspects of the subject so that, having selected an appliance according to the customer's requirements (1) he may be certain it will operate correctly and, from the technical point of view, stand up to the requirements.
(3) To appreciate the economics of customer service to an extent which will prevent him from committing

his Undertaking to an unremunerative bargain or his customer to dissatisfaction.

For example, water heater X might meet all of the requirements of (1) and (2) in that it would satisfy the needs of a restaurant proprietor. Its mechanical construction is such that it satisfies the local Water Authority and its valve will operate with the existing water installation, but the demand to be made upon it may be such as to necessitate its being descaled at intervals of a month. If water heater Y is of equal merit but is either less susceptible to scale formation or is so constructed as to facilitate scale removal it is obviously preferable to heater X for this particular installation.

The technique of appliance selection is so closely linked with the Undertaking's sales policy that digression from the purely service side might be pardoned at this stage.

In order that the salesman shall have every opportunity of satisfying his customer's requirements it is necessary for an Undertaking to market as many varied types of appliance as possible.

The gas appliance manufacturers are to be congratulated on having available an almost unlimited combination of types and sizes of appliance such that there remains scarcely any set of requirements which cannot be satisfied.

Where, however, the larger Undertaking takes a varied helping from this array it sets itself an involved problem from the service angle. Stores, transport, repairs, spare parts, tools, equipment and training of personnel must all of necessity be complicated by such an arrangement.

At the other extreme we have the ideal arrangement from the service point of view of a standard cooker, a standard fire and a standard water heater. Such a standard take-it-or-leave-it attitude would, however, be quickly rejected by the consumers. A satisfactory compromise is, however, effected by the following arrangement:

(*a*) *Short List.*

A very limited range of appliances purchased in large quantity and offered at the most favourable terms. Appliances supplied on demand and all spares and equipment stocked.

(*b*) *Long List.*

Appliances in less frequent demand. Only small and limited stock kept.

(*c*) *Subsidiary List.*

Any approved, safe and reasonably satisfactory appliance (or, more accurately, *any* appliance properly installed). Supplied only on special request. No stock kept.

It will be apparent that in practice this arrangement takes care of itself. The majority of consumers are satisfied by the appliances on the Short List whilst the Long List caters for builders, Local Authorities and the like. Abnormal requirements of any kind can also be met from everything which remains in the Subsidiary List.

A real demand for any appliance on the Subsidiary List will justify its consideration for promotion to the Long or even the Short List.

INSTALLATION AND MAINTENANCE OF APPLIANCES.

The British Gas Industry offers an exceptionally high degree of service to its consumers, and most Undertakings are willing either wholly or in part to take responsibility for the installation and subsequent servicing of any appliances which they market.

The degree of actual installation and maintenance service undertaken will affect the standard of material, equipment and personnel required and the quality of each requires careful determination. While specification and testing will ensure the two former, the latter can be obtained only by proper training. Where, when and how this training is given is an aspect of the subject which, although of the greatest importance of all, is, apart from few exceptions, the one to which least material attention is actually given. Undertakings are universally in agreement that proper training is essential where consumer service is to be given, and it is hoped that this Paper will be of assistance in showing how systematic training is, in at least one instance, being successfully accomplished.

CONTROL OF QUALITY OF APPLIANCES AND MATERIALS.

It has already been established* that the utilization of over half the gas sold in this country is under a close degree of technical laboratory control on the part of the Undertakings.

Of this balance, however, slightly more than one-half refers mainly to the initial design and testing of appliances and equipment. This leaves only about one-quarter of the gas as being used in appliances and with equipment continually under control with regard to quality and general conformity to specifications.

While many manufacturers of repute have adequate equipment to enable them to test each and every article they supply and, in the interest of their prestige, reject any article falling in the least degree below the requisite standard, there remains the problem of price competition and the smaller manufacturer who has not the necessary testing facilities.

The importance of the maintenance of quality in all deliveries of an article subsequent to its approval cannot be exaggerated from the service aspect both with regard to economy to the Undertaking and satisfaction to the consumer.

The work involved in controlling quality generally may be grouped under two headings:

(1) Routine testing of individual articles (all or a percentage of samples selected at random) before acceptance and storage.

(2) Compilation and observation of defects reported by district personnel, complaints from consumers, &c.

Defects brought to light under (1) will immediately prevent trouble and loss of time on the district. The attention of a particular manufacturer can be drawn to the nature of the defect and steps be taken to prevent its occurrence in subsequent deliveries.

A careful record of defects under (2) above will reveal the magnitude of the service problems surrounding any particular appliance, tool or article of equipment. Any defects not anticipated under (1) or during the initial testing of the appliance in the design stage will enable modification to be effected with corresponding reduction of maintenance costs and consumer dissatisfaction.

Co-ordination of Information on Defects.

The knowledge of defects and of the cause of failures should be the means of their elimination, and there should be within an Undertaking one focal point for the examination and classification of the information.*

Most failures fall within five definite classes:

(*a*) The use of materials of inferior quality or unsuitable nature.

(*b*) Poor mechanical or other treatment.

(*c*) Careless assembly.

(*d*) Unsatisfactory design.

(*e*) Faulty installation, use or maintenance.

Defects of all classes can be very costly, particularly to those responsible for the installation and maintenance of a large variety of appliances. Unnecessary labour, material, and incidental costs are often difficult to detect without elaborate and costly systems, and encouragement should be given to all concerned to bring to notice even the simplest defect.

Some defects can only be detected after prolonged use, and in this direction a wealth of useful information can be obtained during the examination and classification of worn and obsolete articles; this work, whenever possible, should be carried out in co-operation with the testing staff. Whatever procedure is adopted for dealing with these defects, the system should be such that each case can be followed to finality and the routine or specification corrected as necessary.

Importance of Liaison between Testing and Instructional Personnel.

Where defects are obviously not due to the article complained of but to the manner in which it has been installed or used by the fitter or recommended by the salesman when not suitable for a particular set of circumstances, a sure indication is obtained of a weakness in the training of the district personnel concerned. Those responsible for training and supervision can be advised and the necessary steps taken to correct erroneous impressions and practices.

TOOLS AND EQUIPMENT.

The cost and efficacy of service is closely allied to the problem of providing tools and equipment to enable the necessary work to be carried out quickly and correctly.

* Stephen Lacey and C. A. Masterman, "National Policies Governing the Testing of Gas Appliances," Trans. Inst. Gas Eng., 1934-35, **84**, p. 648.

* S. F. Dunkley, "Standardization and Quality Control," Trans. Brit. Jun. Gas Assoc., 1934-35, **25**, p. 290.

Not only is this necessary but it is also of the greatest importance to ensure that all tools and equipment are kept in first-class condition or scrapped immediately they cease to be effective.

In this connection the relationship between the replacement cost of a tool or the component wearing parts of it and the cost of repair must be considered.

A hack-saw blade or small file may cost only a few pence. Either will, with normal usage by a gas fitter, quickly reach the end of its useful life. If the fitter retains it and continues to use it he may waste 1 hour per day in unnecessarily prolonged cutting or filing. The first cost of such a tool is so low that it is obviously not worth considering re-sharpening it. It should be scrapped and replaced.

On the other hand, there are many types of tool the cost of which is sufficiently high to justify its repeated repair. Records of large-scale tool repairs indicate that, of the tools meriting repair, the average cost per repair is one-twelfth the cost of the tool.

Many of the improvements in gas appliance design have required new tools or the modification of the design of existing tools.

Appliance Design in Relation to Tools.

In considering the design of a new appliance it is necessary to bear in mind the tools needed to install and service it. Wherever possible the introduction of new or special tools should be avoided. It is normally a simple matter to modify the design of the appliance so that components on which tools have to engage conform to accepted standards and can thus be manipulated with existing tools.

SERVICE PERSONNEL.

Looking back over the history of the craft of gas fitting one finds that the old-time gas fitter was little more than a pipe fitter, whilst the service man or maintenance fitter is a comparatively recent innovation.

In the past the fitter's knowledge and capabilities have not extended beyond his ability to run pipes and connect to the end of them what, in the light of present-day standards, can only be regarded as crude appliances.

To-day we have in the main two types of man: the installation fitter and the appliance maintenance or service man. Both are required to be highly trained mechanics, and it is no exaggeration to say that the modern gas appliance requires for its adjustment and maintenance a knowledge as high as, and in some instances higher than, that possessed by the automobile mechanic. The setting of a refrigerator thermostat with a stroke gauge is every bit as precise an operation as the setting of the contact points of the distributor on a motor car.

Pipe fitting to-day is merely a means to an end. The important factor is the perfect operation of the appliance. The whole training and energies of district personnel must be directed towards this end. The maintenance man must be a specialist. He must be able quickly to diagnose the cause of faults and know exactly how to remedy them and prevent their recurrence.

It is generally agreed that the value to his Undertaking of a good maintenance man is equal to if not greater than that of the average installation fitter.

Organization of Service Personnel.

Since service in its broadest sense commences at the selection of the appliance the gas salesman must be included in the service organization if his work extends beyond the mere introduction of the business. The gas salesman who is merely a contact man to interest prospective consumers in gas appliances and who is followed up by trained estimators and advisers may be ignored as far as service work is concerned.

In the larger Undertaking there is a growing tendency to limit the technical scope of the domestic gas salesman, who thus becomes free to devote the greater part of his energies to sales promotion.

Such an arrangement requires in addition:—

(1) A limited number of more highly qualified specialist salesmen or technical representatives dealing with industrial, central heating, and similar large-scale work.

(2) A nucleus of technical officers supported by well-trained foremen whose duty it is solely to supervise all service work as distinct from sales promotion. Such personnel will ensure efficient work and pay due regard to its cost.

It will not be denied that possibly the most important man in any service organization is the foreman. A good foreman should be a keen disciplinarian, but at the same time he should be the guide, philosopher and friend of his men. If he can take off his coat on a difficult job and show the fitter how it should be done he will gain respect. With the increasing high standard of the young gas fitter of to-day there is no room for the foreman who is not continually ahead of his men in ability and knowledge. Many of our training problems would be solved if sufficient foremen of the right type were available.

It is useless to talk of training and the higher standard of knowledge and craftsmanship required without considering the problem in relation to the type of man recruited and the rates of pay and prospects of advancement offered. With the tremendous encouragement now being given nationally and locally to technical education, is it not desirable to attract into the trade of gas fitting lads from Junior Technical and Trade Schools?

The craft of gas fitting has ceased to be the Cinderella of the building and engineering trades. It has reached a recognized status, and its ranks should be filled from the best recruits available.

PROPOSALS FOR TRAINING.

Operatives.

As the chief co-examiner in Gas Fitting of the City and Guilds of London Institute, the Author should be the last to criticize the Gas Fitting course. The course has done good work over a long period and provides in the main the only possible method of giving instruction to workmen in their spare time. Nevertheless, excellent though the course is, it fails to give the standard of training required by the gas fitter of to-day; not in quality, nor in quantity, but in the sequence and in the time.

The complete revolution in gas fitting practice which has come about in recent years demands that a lad shall be taught the trade in an entirely new manner. Whatever training he receives in the evening or during the day must be in phase with his work and the manner in which he is learning his trade by experience. Training and experience are useless apart. They must proceed concurrently.

The Author is frequently asked: " If the evening classes are so good that you send over a thousand of your employees to them, why do you maintain such a large Training Centre at Watson House? " or, conversely, " if your Training Centre is as good as you say it is, why do you encourage your men to attend evening classes? "

In order to answer these questions, it is necessary to examine briefly:

(i) The Gas Fitting course.
(ii) The best method of teaching the modern gas fitter his trade.

The Gas Fitting course aims at teaching a man the general principles of gas fitting practice as accepted throughout this country. A man who qualifies in it and obtains the City and Guilds of London Institute certificates should be able to go to any Undertaking in the country and practise as a gas fitter. The course does not, however, cover any specialized or local knowledge. At each successive stage of the course the student covers practically the whole sphere of the work to an increasingly advanced standard. At no definite stage in the course can the lad be regarded as competent to undertake any particular branch of the work. He thus takes 5 years to learn the complete trade with each branch of it running concurrently over the whole period.

We now know how imperative it is to have men who are specialists and have covered a particular subject so intensely and thoroughly that they can be employed on that work with confidence.

The obvious way in which to train such men is through the stages of gas appliance maintenance. Make them gas appliance mechanics first and foremost and let pipe fitting be ancillary to their knowledge of appliance adjustment and maintenance.

By means of a progressive system of specialized courses of training they can be turned out as competent men employable in capacities up to the standard of their attainments, each successive course being regarded as promotion. Actual district experience is gained as each course is passed and before proceeding to the next.

There is still no reason, however, why the ambitious lad should not take the Gas Fitting course at evening classes and so gain a general knowledge of his trade.

The establishment of this system of courses at Watson House has proved the advantages of this scheme of training.

If such training be thought desirable of application to the country as a whole, how can it be accomplished by the smaller Undertaking in the remoter parts of the country? The organization of such specialized day training courses necessitates:

1. Adequate accommodation and equipment.
2. Release of sufficient men from work to form a class.
3. Competent instructors.

The extension of the Watson House Training Centre facilities to some 72 subscribing Undertakings appears to offer the solution to the problem, and it is suggested that similar Centres might be prepared to establish training schools and to offer comparable facilities. Twenty Gas Undertakings would experience little difficulty in each releasing one man for a week at a time. A class of 20 could thus be formed and trained at the Centre.

Staff and Foremen.

It is difficult to generalize with regard to the qualifications required by supervision personnel, as the duties vary considerably with the size of the Undertaking. In the smaller Undertaking sales and service, and frequently distribution, are undertaken by the same persons and a more general but less specialized knowledge is required. The training gained up to the Ordinary Grade in Gas Supply coupled, if possible, with the Final Certificate in Gas Fitting should cover the needs of the majority. Those who show particular aptitude might be encouraged to proceed as far as the existing Higher Grade in Gas Supply.

The more specialized knowledge required by individuals in the larger Undertakings demands an initial training up to the standard of the Higher Grade in Gas Supply and, according to the individual's occupation, further specialized training in such subjects as heating and ventilating engineering, illuminating engineering, industrial work, &c. Personnel whose sole duties consist of the supervision of consumer service—usually termed Service Supervisors, or Fittings Superintendents—could with advantage be selected from those who have had a general engineering training and who have had previous responsibility in controlling men and costs.

It must be repeated that the foreman is the key man of the service organization and on that account his training should be the best possible. Fitters who have completed their training and gained sufficient experience should, if they show the necessary aptitude and possess all the other important qualifications of conduct, punctuality, appearance and—most important of all—personality and character, be given an early opportunity of receiving special training as foremen.

An ideal method of doing this is to employ them for a short time as instructors. A man who can teach and maintain discipline is usually the right type for promotion, and, of course, in order to teach he has to learn and this period as an instructor serves as a useful finishing school. This method has been tried with great success at the Watson House Centre and can confidently be recommended for adoption elsewhere.

Refresher Courses.

The rapidly changing conditions brought about by research result in service personnel continually being called upon to handle new appliances, new materials and adapt themselves to new methods. The initially well-trained man very quickly becomes out of date in his outlook unless adequate measures are taken to keep him abreast of all developments. This can be achieved in a variety of ways:

(1) Refresher Courses.
(2) Issue of Technical Bulletins.
(3) Supervision by foremen who are themselves up-to-date and able to pass on all new ideas.

As far as the fitter is concerned, the only really effective method is for the man to attend a short refresher course and himself handle the new appliance or fitting and be shown exactly how to do the necessary work. No amount of written or verbal explanation will, for example, convince a fitter of the efficacy of the capillary-soldered joint for light gauge copper tubing. The only way to demonstrate it to him and gain his confidence is to show him how to make it, let him make several for himself and then cut them in section.

The duration of a refresher course will depend on the amount of development work which occurs during the periods between the courses. From one to two days each year should normally suffice to show every fitter the year's progress.

CONCLUSIONS.

From the considerable experience of customer service problems obtained in this country it might well be asked:

(1) What does complete customer service cost?
(2) Does it pay? *i.e.*, is it worth the trouble?
(3) Can too much service be given?
(4) What is the ideal system?

The subject can, perhaps, be summarized in brief by concise answers to these questions.

What does complete customer service cost?

Gas Undertakings normally have no source of revenue other than that obtained from their customers. No work can be done free without the cost of it being recoverable in the charge for the basic commodity gas or included in the sale price, hire purchase or rental terms of the appliances.

The practice in London is to install appliances "free" (*i.e.*, at an inclusive price) within certain limits of availability of gas and water supplies and to give "free" maintenance service. All overheads are included in the price or rental of the appliance. The maintenance scheme has reached such a high standard of efficiency that there is actually a slight profit made which can be utilized in still further improving the service.

The economics of service depend largely upon the number of interim complaints. If the periodical visits are effective the interim complaints will decrease.

The cost of training is high and, if the training given is to be of the high standard required quality must not be sacrificed on the grounds of economy. The cost of training must be regarded as an insurance premium. Failure to pay it means loss of customer satisfaction, high labour costs, and frequently the meeting of heavy claims for compensation on account of damage to property and persons. Opinion regarding the desirability of proper training is in such universal agreement that argument in this respect is redundant.

Can too much service be given?

It is a fact that one can be too kind in many respects and, with certain persons, the more that is done for them the more they expect and demand. While it is generally agreed that the best possible service should be given by Gas Undertakings to their customers, a proper balance should be preserved. The following example will illustrate the extreme to which unqualified service may extend.

An American Gas Company was so anxious to give satisfactory refrigerator service that it promised to supply free ice in the event of any refrigerator breaking down. While this was a fairly safe offer for a Gas Undertaking to make, it resulted in certain people telephoning for ice at midnight when some thoughtless member of the household had turned off the gas. But imagine the plight of the staff of an electrical undertaking who, having made a similar promise, found themselves obliged to honour it in the course of a four-hour black-out!

Service must be fair to customers; it must be good; it must be reliable; but it must be on a sound economical basis and kept within its proper sphere.

What is the ideal system?

As explained at the outset, so much depends on local conditions that it is difficult to give definite recommendations. Three things are, however, essential to a sound service policy where they are at all possible:

(1) The Gas Undertaking should be responsible for the installation and maintenance of the appliance it approves and recommends, irrespective of its sales policy.
(2) Adequate control of materials, tools, and equipment must be maintained.
(3) Service personnel must be properly trained, kept up to date, and adequately supervised.

The real backbone of customer service is the training of the personnel. Here there are two schools of thought, the Undertakings who believe that every service man should be able to deal with every job as against the theory that specialists should be employed for such things as refrigerator and water heating work. Probably the answer is that it depends upon the size of the Undertaking and that largé Undertakings do best with specialists and small Undertakings with the all-round workmen. Whichever system is employed, it is essential that good foremen or specialists be available.

As the labour side of the service given is the most expensive, so it is logical that it should be the most studied.

Money cannot be over-spent if it be well spent in this connection, since the more expert the men the fewer will be the requests for service and the greater will be the reduction of complaints and of loss of business.

Training Scheme of the Gas Light and Coke Company.

The Training Scheme was first started in 1909 when the Gas Light and Coke Company, in conjunction with the Education Officer of the London County Council, established a plan for the apprenticeship and training of lads to become gas fitters in the Company's service.

The scheme has been in continuous operation for 28 years

and has provided the basis for the more comprehensive Training Establishment which exists to-day.

As an apprenticeship to provide gas fitters the original scheme failed or rather, it is more true to say, proved too successful in that the type of lad recruited in the early days was so good that practically every one rapidly gained promotion beyond the ranks of gas fitter.

The expansion of business which commenced about 1925 called for a revision of the scheme and it was then extended so as to provide for the entry of a definite number of skilled mechanics each year. In addition, a Staff Pupilage Scheme was inaugurated to provide a limited number of well trained entrants to the administrative and technical staff.

Continued expansion, coupled with the fluctuations in labour requirements, render it impossible to forecast conditions five or six years ahead so that it becomes necessary to limit the numbers of apprentices indentured each year and to permit of other means of entry for gas fitters according to labour demands. The moving of Watson House to more commodious premises at Fulham, in 1936, was made the occasion for a long desired increase in accommodation for training, bearing in mind the needs of the controlled Undertakings of the South Eastern Gas Corporation and the Undertakings subscribing to the Watson House Domestic and Industrial Centre Scheme.

Organization.

The activities of the Training Centre consist of:

1. *Actual Training Work.*

   (*a*) Apprenticeship Scheme.
   (*b*) Training of Fitters and Maintenance Men other than those who commence as apprentices.
   (*c*) Training of Service Supervisors, Staff Pupils, Salesmen, Foremen and Assistant Foremen.
   (*d*) Refresher Courses of all kinds to keep all grades of personnel up-to-date.

2. *Work Other than Training, but Allied to it.*

   This might be described as the general interpretation to the District Service Personnel of the technical work undertaken by the laboratories.

Gas Fitter Apprenticeship Scheme.

Entrants are graded in two classes—Class A are lads from elementary schools who are indentured between the ages of 14 and 16 and serve an apprenticeship for a period of six years, while candidates for Class B apprenticeship must have attended a full-time course at a junior technical or trade school and are thus considered for indenture at the age of 16 +. Class B apprentices serve for 4½ years and, on entry, are grouped with Class A lads who have completed their first 1½ years' training.

Applications are entertained only in respect of physically robust and intelligent lads who show evidence of possessing mechanical aptitude and manipulative ability. All candidates must submit themselves to a carefully devised series of tests for intelligence, general knowledge, ability, &c.

The first three years of apprenticeship for Class A boys, and the first eighteen months for Class B boys are spent in full-time training in the shops. These workshops are fitted with all necessary plant and apparatus for the purpose of giving thorough practical and theoretical instruction. Special instruction in Technical Drawing, Workshop Calculations, English, Elementary Science, and Organized Games is provided at the Technical Institute. During the first two years of apprenticeship the instruction at the Westminster Technical Institute is given during working hours. In the third and subsequent years attendance at evening classes is required. Throughout the apprenticeship all class and examination fees and travelling expenses incurred in attending evening classes are paid by the Company. Progress and conduct at these classes is under the immediate supervision of the Company, and is taken into consideration when increases in pay are due. After three years in the workshops, apprentices go out with gas fitters on the district where their training is continued and they return to the workshops from time to time for instructional courses of training.

One week's holiday with pay is granted each year subject to satisfactory timekeeping.

Lads are encouraged to take part in games and sport. The Company has several sports grounds and a special section of the Company's Sports Association caters for lads up to 18 years of age. A summer camp, usually by the sea, is also organized by the Company for lads in their employ, where an enjoyable week's holiday can be spent under proper supervision at a moderate cost.

Apprentices must be prepared to work at any depôt or on any district in the Company's area of supply, but as far as possible they are drafted to districts within a reasonable distance of their homes.

The hours worked by the apprentices are 44 per week in the first two years and 47 per week in the third and subsequent years.

The lads are paid during apprenticeship, subject to satisfactory conduct in the Company's service and at school, in accordance with a progressive scale. The amount of increase granted each year depends upon conduct and progress during the preceding year.

The Company does not bind itself to provide employment for apprentices at the expiration of their Articles of Apprenticeship, but every endeavour is made to find suitable employment for those lads who have been satisfactory as apprentices. Opportunities for further promotion naturally depend on work and ability.

The Company reserves to itself the right to discharge any apprentice who may be found unsatisfactory, and to cancel his Articles of Apprenticeship.

Training Courses.

All embryo fitters, whether entering the Company's service as apprentices or not, are made to attend a progressive series of training courses during the early years of their service. The majority of these courses are of one week's duration, and the subject matter is designed to take the trainee gradually through the technique of gas fitting by means of a thorough knowledge of the maintenance of gas appliances. Actual installation work is not taught until the two final courses are reached. At any stage of the training a man is employable on work up to the standard of his training at that stage.

Other special courses of training exist for staff personnel and foremen.

All courses include both practical and theoretical tuition and terminate with an examination on the work covered by the training.

Refresher Courses.

No matter how effective the initial training of district service personnel may be, the ever-changing conditions attendant upon development and progress render it imperative to maintain a system of refresher courses.

Every member of the district staff attends Watson House three times each year for a lecture-demonstration when all new appliances and developments are explained in detail. Occasional special staff refresher courses are held as, for example, the week's refresher course on water heating which is in progress at the time of writing. Some 900 outdoor representatives and salesmen are attending this course. Two classes of 20 are held simultaneously each week, so that the course will run for nearly six months.

Every trained fitter attends at Watson House for a refresher course once each year regularly. The length of the course each year varies with amount of development work which has occurred during the previous year. It is usually of two or three days' duration.

The particular object of the fitters' refreshers is to enable each man to handle and adjust new appliances and actually to perform new operations, as no amount of written and verbal instruction appears to be quite as effective.

Examinations and Records.

Considerable investigation into all methods of examining large numbers of mechanics has revealed the undesirability of both the essay type of theory paper and the *viva voce* test. Both types of examination have proved difficult to both examinee and examiner. The former is difficult to mark; being unfair to the illiterate trainee and often producing several pages of foolscap from the man with a flair for detailed description of irrelevant points. The *viva voce* examination is unfair to the nervous man who frequently becomes quite inarticulate when confronted by the examiner while the garrulous candidate may waste time.

The solution to the problem lies in the modern "one-word" answer to each of a series of snap questions. Hundreds of such questions can be asked and answered in a very short time. This type of examination has been very successfully applied in the U.S.A. Navy and Army and has now been adopted in the elementary schools in this country. The questions can be either dictated or supplied on printed slips with spaces for the answers. By means of key answer slips marking is a matter of minutes and absolute fairness is ensured. Another advantage is the large field of knowledge which can be covered in a short time. A specimen page of a typical paper is shown in Figure 1.

Technical Information Bureau.

The establishment of a Technical Information Bureau as part of the training activities at Watson House enables

anyone on the district to telephone and obtain information or assistance either in a difficult problem or where knowledge is lacking.

The Bureau does not pretend to be able to answer any

2.

9. State two important reasons for fitting a baffler on fluepipe which communicates to the outside air.
   (*a*)
   (*b*)

10. Name the two principal products of complete combustion of town's gas.
   (*a*)
   (*b*)

11. What types of burner jet would you order for the following water heaters:
   (*a*) Potterton "Empire"
   (*b*) Potterton "Emperor"
   (*c*) "Magic" 2B
   (*d*) "Equator"

12. What precaution would you take to ensure that no air lock entered a system when recharging with water?

13. State in their correct order the steps you would take after maintenance to ensure that the thermostat on a "Sunhot" would close down to maintenance rate.
   (*a*)
   (*b*)
   (*c*)
   (*d*)

14. How is the rate of flow of water controlled in the following appliances:
   (*a*) Sunhot Accumulator
   (*b*) G.L.C. Circulator
   (*c*) B.T.U. Junior Circulator

15. State three possible causes of the flames in a water heater smothering.
   (*a*)
   (*b*)
   (*c*)

16. Approximately how long should the following heaters take to shut down to by-pass if no water is drawn off.
   (*a*) Equator 13
   (*b*) Ruud 18

FIGURE 1.—*Specimen Page from Typical Theoretical Examination for Fitters (Course G).*

and every technical question off-hand, but it does profess to know where to obtain the information. A record of all enquiries is kept and this serves a useful purpose in indicating where knowledge is weak. If a repeated number of questions on the same subject is asked it shows that more attention to that subject must be given in the training courses and also a reference should be made in the bulletin.

Frequently the request for information is such that it can only be answered by sending an instructor out to the job to advise or give assistance *in situ*. A number of instructors set aside for this work take turns to do it. The instructors are thus themselves kept up-to-date with district conditions.

A record of calls made in this manner is kept; each particular type of defect or installation being recorded on a separate type of form. Any information regarding faulty design is passed to the laboratories, while incorrect installation methods are referred to in the bulletin and made the basis for more intensive training where necessary.

SUBSCRIBING UNDERTAKINGS SCHEME.

Following the success of the Industrial Centre Scheme it was decided to extend the facilities available at the Watson House Centre to include also problems connected with domestic appliances. As a result 72* Gas Undertakings are now subscribing towards the Watson House Domestic Centre. The organization of the scheme is in the hands of a senior officer of the Watson House staff, who maintains contact with selected individuals representing the managements of the various subscribing Undertakings. In this way overlapping and confusion is avoided.

Monthly meetings are held, at which the representatives from the subscribing Undertakings exchange views in conference and are free to solicit any technical information they require. A quarterly bulletin is circulated, giving full technical reports of all work undertaken at Watson House and, in addition, the monthly bulletin and other publications are issued. Additional copies are circulated in any desired numbers at cost price.

An interesting development of the scheme has been its extension to include the training of personnel from the subscribing Undertakings. This work has now been in active progress for six months, during which period sufficient experience has been gained to leave no doubt as to its value.

The work is charged for at cost at the rate of £1 per person trained per week. The majority of the men attending find it necessary to obtain board and lodging, owing to the distance travelled, and in this connection a list of over 300 suitable lodgings in the neighbourhood of Watson House has been obtained.

A fixed rate of subsistence allowance has been agreed upon by all Undertakings in the scheme. This is 6s. 6d. per day for workmen and 8s. per day for leading hands. Inspectors and other officers are dealt with specially according to individual requirements.

The total cost of sending a fitter from, say, Folkestone, for a week's training is thus:

	£	s.	d.
Wages (say)	3	0	0
Return fare	0	13	0
Subsistence allowance (5 days at 6s. 6d.)	1	12	6
Watson House charge	1	0	0
Total	£6	5	6

A report on each trainee is sent to the Manager of his Undertaking (Figure 2).

THE GAS LIGHT AND COKE COMPANY.

TRAINING CENTRE, WATSON HOUSE, FULHAM, S.W. 6.

TRAINING REPORT.

NAME..... RANK.....

UNDERTAKING.....

COURSE .... PERIOD: From.....To.....

EXAMINATION RESULTS

Practical.....
Theoretical .....
Viva Voce .....

GENERAL OBSERVATIONS (where applicable)

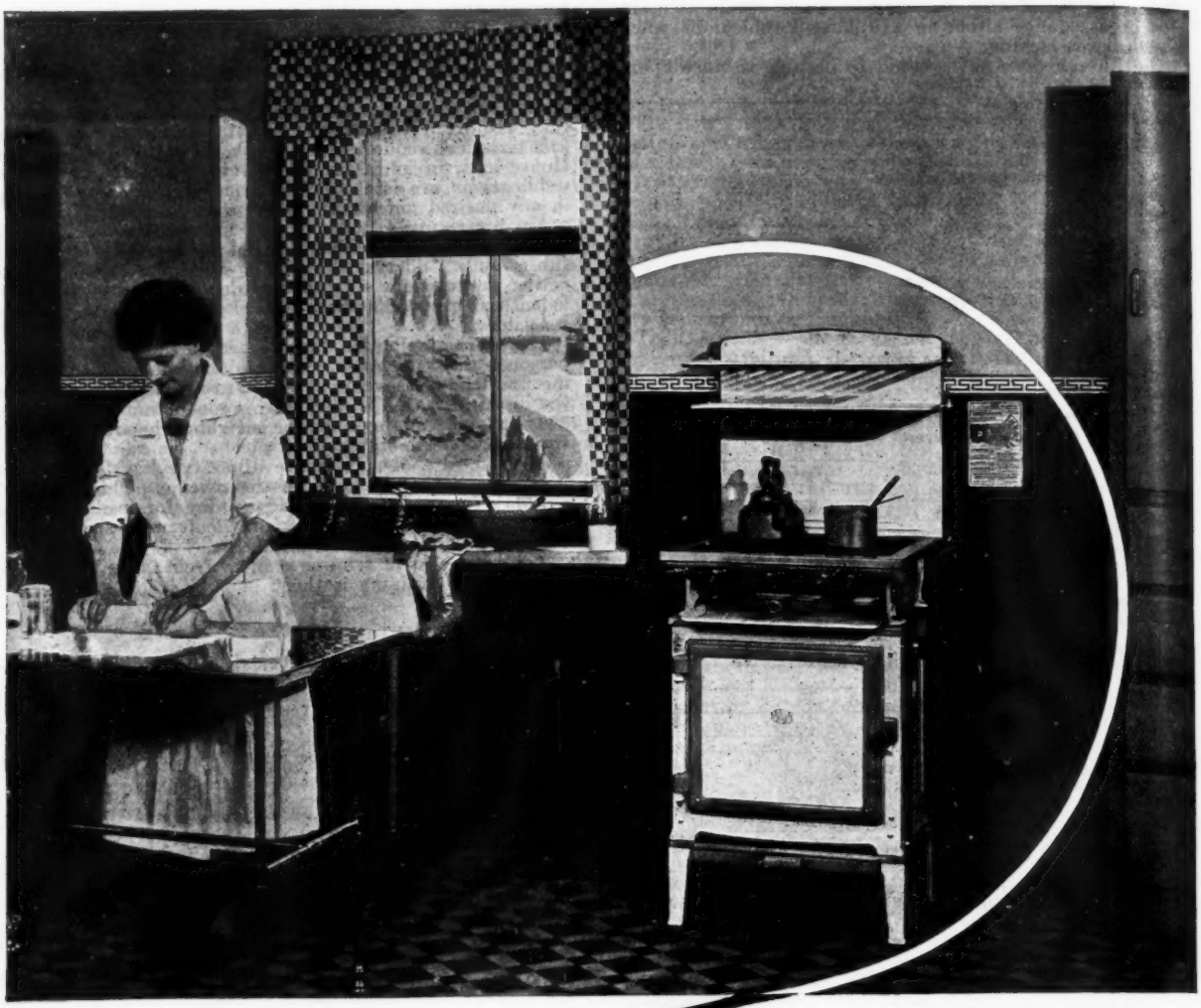
Conduct .....
Timekeeping.....
Work.....
General Intelligence.....
Mechanical Ability .....
Manipulative Skill .....
Technical Knowledge .....
Sales Aptitude.....
Appearance and Personality .....

RESULT OF COURSE..... .....

REMARKS:

FIGURE 2.—*Form Used for Report on Trainee from Subscribing Undertaking.*

* Including the companies constituting the South Eastern Gas Corporation, Limited.



An ascending curve

Still gaining in popularity

SUSSEX Cookers are making more and more new friends for Gas. Throughout the length of the country they are adding to the prestige of Gas Cooking.

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Home Production of Oil

Mr. J. Jamieson on the Potentialities of Cannel

A lead from Government Departments in connection with the production of oil-from-coal was suggested by Mr. James Jamieson, Engineer and Manager, Edinburgh Gas Department, in a talk which he gave to the Edinburgh City Business Club at their lunch in the North British Station Hotel on May 18.

A good deal of publicity, he said, had rightly been given to the investigations carried out at Granton in conjunction with the Fuel Research Board on the potentialities of cannel as a contributor to our supplies of home-produced oil. More than 20,000 tons of cannel were treated over a period of 14 months, and 12 complete tests or examinations were made. The ordinary gas-works retorts were used, and no special arrangements or alterations were made beyond those required for handling and segregating the liquid products. No large capital outlays were therefore essential for the immediate utilization and exploitation of suitable cannel in a modern gas-works.

The attraction of cannel for the production of oil was that it dovetailed so effectively into an existing industry. It, therefore, served a dual purpose, particularly in the event of war. Less cannel would be required for the same output of gas, and fewer men would be required to handle it at the pits and at the gas-works; fewer railway wagons and less plant would be needed for the conveyance and handling of the material.

Ararat's New Community Hospital

Gas Provides Essential Services

Prior to the commencement of the building of the new hospital which was recently completed at Ararat, Victoria, exhaustive enquiries and investigations were made by the Hospital Committee and architects as to the most suitable fuel to be used for the essential services. Many aspects had to be considered very carefully, and it was thought at one stage that it would be necessary to install a large steam boiler to provide for the laundry, sterilizing, and part of the cooking.

The local Gas Company, however, were able to convince those concerned that gas would perform all these duties satisfactorily and, at the same time, considerably reduce the actual overall running costs as compared with other systems. In order to ensure a satisfactory supply to the hospital for all occasions, the Gas Company laid a new 4 in. main, and, while the output of gas is steadily increasing for all purposes, this new main guarantees that there will always be an adequate supply for the hospital. All the appliances installed are of the latest type, incorporating thermostatic control and porcelain enamel or chromium and stainless steel finish.

Gas plays a most important part in the kitchen, the very latest type of range and accessories being installed to take care of the cooking requirements for the whole hospital.

The many gas sterilizers, installed in all parts of the hospital, incorporate a number of new features, including thermostatic control, automatic ignition, and constant water level. They are also fitted with special automatic controls. The sterile water unit is an interesting piece of equipment. It is fixed in the ceiling and sterile water is automatically provided as and when required. When sterile water is required in the birth room or operating theatre, it is drawn from the storage in the roof, and the drawing off of this water automatically sets the gas-heated unit into operation to replenish the supply thus used. The moment the storage cylinder is filled, the gas burner is automatically lowered to a pilot flame.

The laundry-block, which is being re-equipped with new machinery, will take care of the hospital laundry requirements. It was thought earlier that it would be necessary to utilize steam in the laundry, but it is interesting to note that no steam at all is required, and gas is again taking care of the requirements. The large rotary washing machine requires water from cold to practically boiling point, and this is provided by an automatic gas circulator and a 100-gallon storage cylinder, which will provide an unlimited supply, as and when required, without any work or preparation beforehand. The ironing machine is one of the latest type, and, being gas-heated, is also fitted with a thermostat, which automatically reduces the gas consumption when the desired temperature has been obtained. The old drying room which was steam-heated, in the old hospital, has been altered and enlarged and a gas furnace will provide warm air through the air ducts for the drying of the clothes. This new method circulates the warm air through the drying room and the result will be that the period required for drying will be reduced considerably. A gas-heated soap dissolver will be used and similarly a gas copper for miscellaneous work. The drying room in the laundry is the first of its type to be used in hospitals in Victoria.

Tar and Ammonia in 1936

Increased Production of Sulphate of Ammonia

The following information is extracted from the Report for 1936 of the Chief Inspectors of Alkali, &c., Works (H.M. Stationery Office, price 1s.).

TABLE I.—*Ammonia Products Manufactured in England and Wales.*

[Expressed as Sulphate (25¾% NH_3)—Tons.]

From Liquor Produced in—	1936.	1935.	1934.
Gas-works	120,300	109,200	102,300
Other works (including coke ovens, iron works, producer gas, synthetic, &c.)	455,100	461,700	458,700
Total	575,400	570,900	561,000

NOTE.—Of the above total, the equivalent of 100,200 tons was manufactured as concentrated liquor, and 29,400 tons of this concentrated liquor was subsequently converted to salts, which are included in the 575,400 tons above. The total quantity of salts of ammonia produced, therefore, was 475,200 tons and the net production of ammonia was 546,000 tons.

TABLE II.—*Tar Treated in England and Wales.*

[Tons.]

Origin.	Tar Distilled.	Pitch Produced.
Gas-works	1,060,000	275,200
Coke ovens	709,900	260,500
Other works	20,000	7,600
Total	1,789,900	543,300

NOTE.—Of the above total quantity of tar, it is estimated that 1,013,200 tons were distilled for the production of pitch, the balance of 776,200 tons bein treated only for the preparation of road tar, &c.

TABLE III.—*Salts of Ammonia Made in Scotland.*

[Expressed as Sulphale.]

—	1936.	1935.	1934.
	Tons.	Tons.	Tons.
Gas-works	13,814	13,245	12,269
Iron works	210	215	295
Coke ovens	9,524	7,404	6,392
Shale works	24,707	25,398	25,240
	48,255	46,262	44,196

NOTE.—Included in these totals are 836 tons recovered as liquor ammonia and 66 tons as ammonium chloride.

TABLE IV.—*Tar Made in Scotland.*

—	Tar Distilled. 1936.	Pitch Produced. 1936.	Tar Distilled. 1935.	Tar Distilled. 1934.
	Tons.	Tons.	Tons.	Tons.
Gas-works	142,335	37,315	130,067	134,979
Iron works	2,345	1,238	4,932	3,298
Coke ovens	28,366	9,154	20,509	19,985
Producer gas	..	..	127	117
	173,046	47,707	155,635	158,379

A Correction

We are asked by Mr. W. H. T. Johns, Engineer and Manager at Rotherham, to correct the details of Coronation floodlighting given in our issue of May 12. Gas floodlighting was installed at the Gas Offices, Showrooms, Chantry Chapel, and Rotherham Hospital, and not the Art Gallery, Museum, and Library.

GENERAL GAS AND ELECTRICITY COMPANY, LTD.

A pleasant and instructive day was spent at the Works of Messrs. George Wilson Gas Meters, Ltd., Foleshill Road, Coventry, on May 19, on the occasion of a Staff Conference of the General Gas and Electricity Company, Ltd. In the morning there was a Conference under the Chairmanship of Mr. W. A. SCOTT.

Visit to the Works OF George Wilson Gas Meters, Ltd.

A Paper was given by Mr. E. W. Messer (Secretary of the General Gas and Electricity Company and Subsidiary Companies) dealing with the system of records and statistics in operation at the various works controlled from 50, Cannon Street. A general discussion followed when Managers were given an opportunity of raising points dealt with in the Paper and of comparing experiences in connection with technical and other matters. Following this there was a lecture on the construction, working, and use of gas meters by Mr. D. E. C. Poole (Director, Messrs. George Wilson Gas Meters, Ltd.).

Mr. Scott said they had about 30 gas companies in the offices at Cannon Street, and they found it convenient to meet occasionally to compare notes. They had not made it an annual affair and it was about three years since they were last together so that the Managers might compare notes. The organization had grown to such dimensions that they could not have all the Managers up at the monthly meetings but various excursions were made into the country. He came down and Mr. Wilkinson, their Engineer, to various works, and it was found to be an advantage to supervise in that way and to broaden their knowledge and that of the various Managers. It helped greatly in ascertaining the best methods to adopt in the various works. Mr. Wilson had very kindly invited them to inspect their Works and they were glad to do so.

Paper on Gas Meters.

In his Paper, Mr. Poole said he did not propose to go into the past history of gas meters but he would point out that prior to 1920 little progress had been made in the improvement of the old meter. In 1920 the standard meter was introduced but this only met a small demand. In 1928 they had the introduction of the high-capacity meter which began to go some way towards meeting modern requirements. A little later, towards 1930 or 1932, after talking it over with engineers and the like manufacturers decided that the small high-capacity meter was the one to meet all demands. Architects seemed to forget when they designed houses that a meter was required, while a modern house required a great deal of gas, or should do so; thus the small meter was brought into existence.

Perhaps they might think it was rather puzzling that they could make improvement in meters as the fundamental design was the same as when they were first brought out, but science had given knowledge to the manufacturer and the meter had undergone big changes. The principle remained the same but the set out was now done geometrically in place of the old rule of thumb methods.

In the first place the valve plate had undergone a big change; whereas the old type valve plate was far from a geometrical problem, to-day a formula was necessary to lay a valve plate out, for on this plate depended the correct positioning of the valves, crank, and flag wires. If the flag rods were not in correct position with the crank and valves, perfect timing was impossible, and oscillation and absorption were bound to result. All valve plates were a perfect geometrical equation. The valves again required special attention. Metals had to be considered and proportions exact, otherwise wear and squeaks would result. Thickness of the bars and supports were essential factors to the perfect valve. In all their meters they fitted straight line valves. It would be noticed in all their meters that when the cover was in the closed position, that was when the cover was in the central position, the two measuring chambers were open to the gas supply and only the exhaust port closed. When the valve was in this position the leather controlled by that valve was at the end of its stroke and if the valve shut all chambers the leather would have to move in a sealed chamber, thus compressing the gas one side and expanding it on the other. This was only slight but gravely detrimental in putting stress on the leathers. As this occurred four times in every revolution of the meter it became serious but was entirely removed on a meter fitted with straight line valves. Leathers, too, had received a great deal of attention. The tannage and dressing were far different to-day from the old vegetable tannage of the days previous to 1920. Every leather used in the manufacture of their meters was chrome tanned and of the disc type which was common to all sizes. No leather fitted to-day had seams, which in the bag type leather were the cause of much unregistered gas passing through the meter. The preservative dressing of the diaphragm required much thought. Oils which were considered essential in the old days were absolutely useless to-day. Many of the vegetable oils were saponified when coming in contact with gas for only a few hours. They always advocated a closed top meter. For a period they manufactured an open top meter for different undertakings to meet their requirements, but they generally suffered as much as the undertaking which adopted that type.

Prepayment Attachment.

Mr. Poole then dealt with the prepayment attachment. He said in this direction as well as in all others simplicity must be emphasized, for the more complicated the mechanism the more trouble would be experienced. The single coin or " Companies' Optional " no doubt helped in the sale of gas. This might be questionable, but those present were the people who could answer best if this attachment was a vital necessity or not. The single coin required little or no explanation. The optional was worth a little attention. The first question must be—was it simple, how many wheels had they to contend with, and would it creep? Their aim had always been to produce a mechanism of as simple a construction as was humanly possible with all the safety factors both from the consumers' and companies' points of view. Their optional attachment had as few wheels as possible, and was of robust construction. With this feature acting between the meter mechanism and the coin mechanism it ensured that no creep could take place no matter how much strain was exerted by the closing of the prepayment or auto valve. He pointed out that all the strain exerted must receive its motive power from the gas through the medium of the

leathers or diaphragms of the meter. Thus they saw that if a prepayment valve became dirty from any cause the leathers were the sufferers, the gearing or some other part breaking if the strain became too great. The prepayment valve, therefore, in the construction of a meter must receive a great deal of attention. Time did not allow him to go into details of all the troubles which came about through faulty prepayment valves. Some undertakings realized the seriousness of dirt and his firm manufactured a simple filter which was placed on the inlet of the meter and arrested the dirt before any harm could be done to the correct working of the meter. "We are out," he said, "to help the Gas Industry as much as possible, and during the past few years we have put on the market quite a number of mechanisms for the benefit of the sale of gas."

The Chairman proposed a vote of thanks to the lecturer for what he described as a most interesting Address.

The company was entertained at luncheon under the chairmanship of Mr. J. H. Wilson, who extended a cordial welcome to the visitors. The firm looked upon the visit as a great honour and hoped that it would be repeated. It had been a pleasure to serve Mr. Scott's organization, and its future prosperity was assured under his guidance.

Mr. Scott thanked the firm for the kind reception they had given the visitors. He proposed the toast of "The Chairman and Prosperity to the Company." They congratulated the firm upon the strides that had been made in the perfection of meters. They were fully alive to the necessities of the times and they had the faculty which was so often lacking of anticipating future requirements. The firm was to be commended for that and for the foresight that was shown in research operations.

Mr. F. C. Wilson thanked Mr. Scott for kind words.

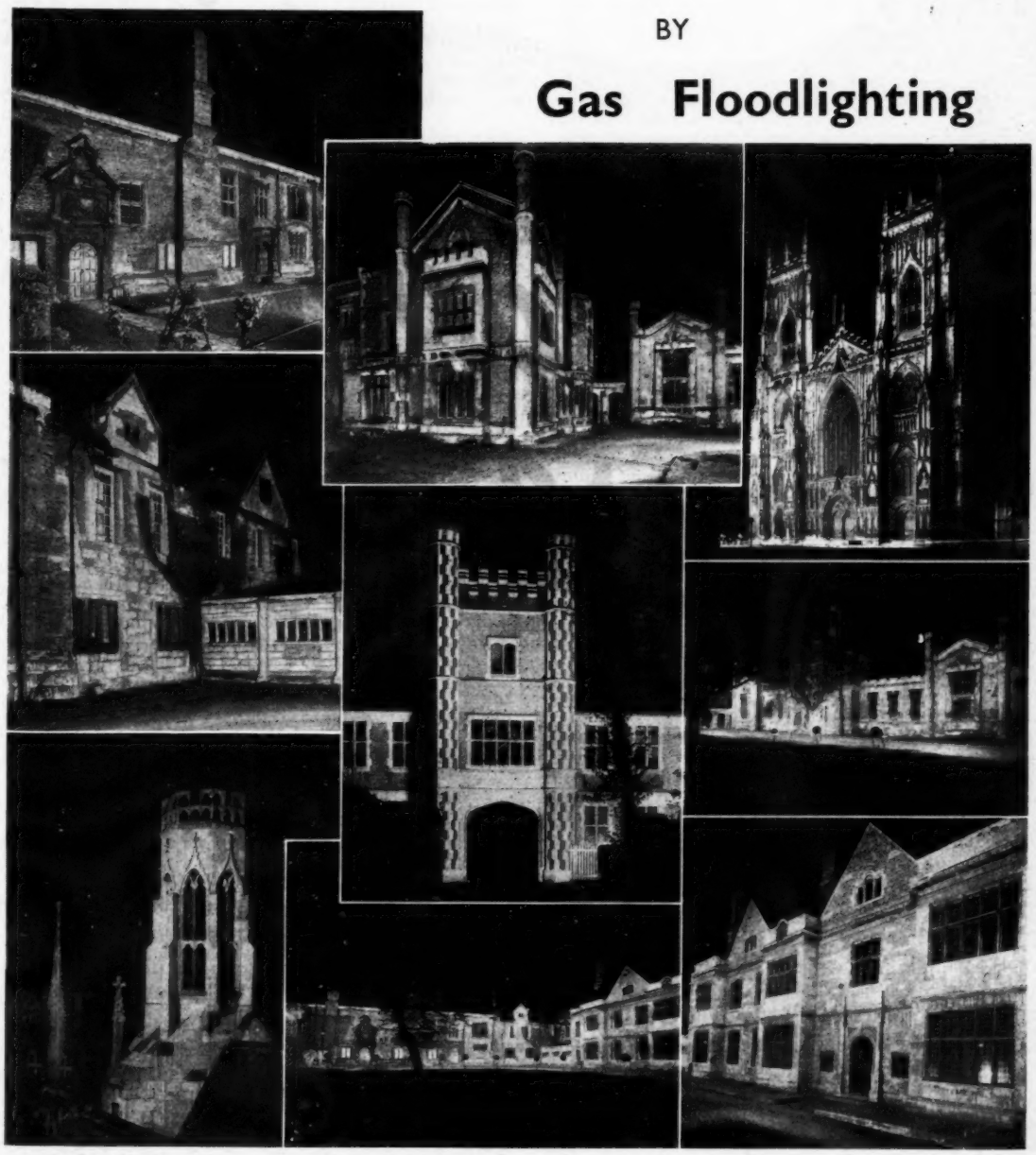
Mr. W. D. Wilson, son of the Chairman, proposed the toast of "The Press" and expressed thanks for the co-operation and assistance that were always forthcoming. Without that it would have been impossible for the Industry to have reached the position it occupied to-day.

Mr. J. H. Moss, Midlands District Manager for the "GAS JOURNAL," responded.

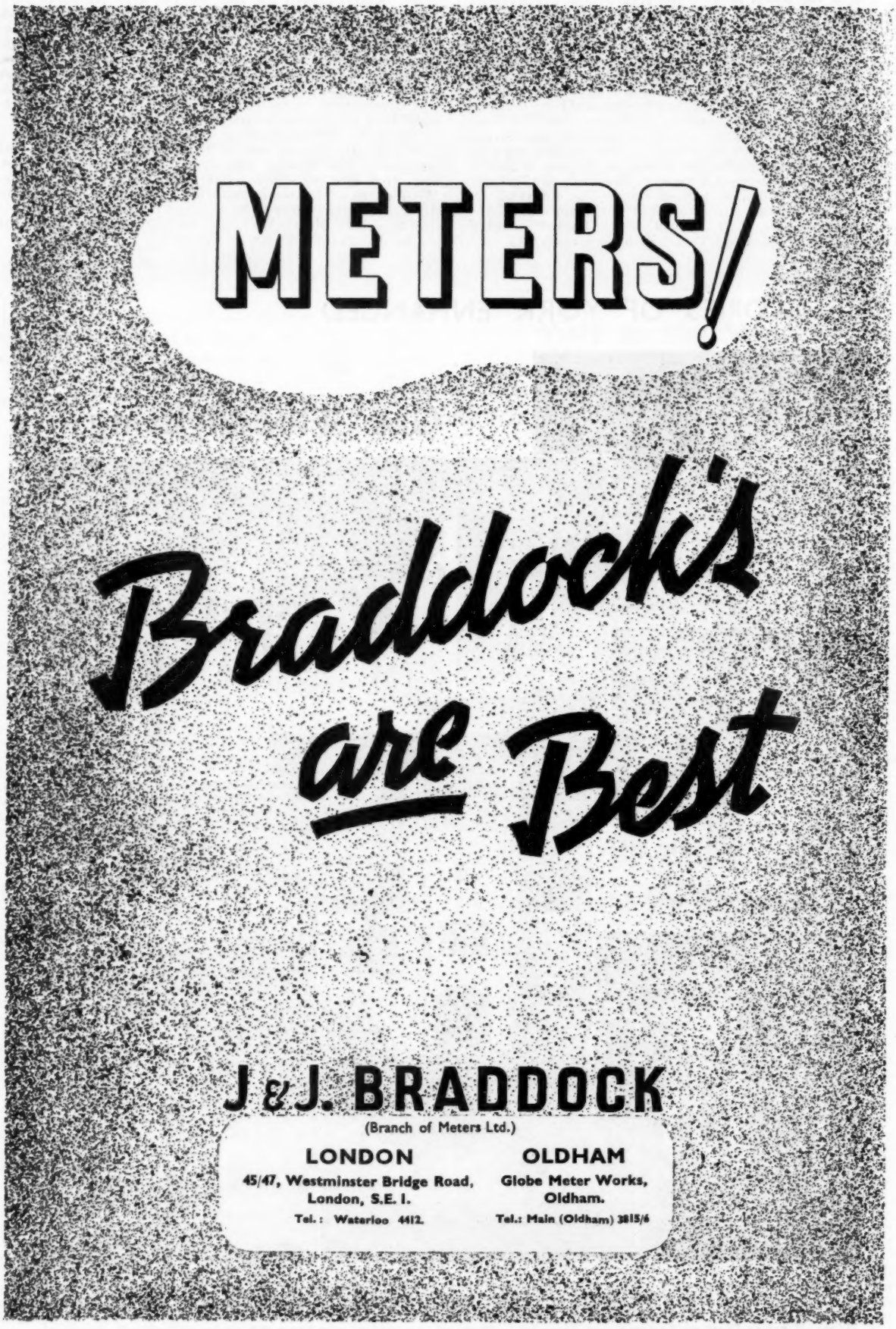
THE GLORIES OF YORK ENHANCED

BY

Gas Floodlighting



Specialists in artistic floodlighting, the York Gas Company carried out a Coronation programme on a very extensive scale. We are unfortunately able to reproduce but a few of the many splendid examples, for which we are indebted to Mr. H. E. Bloor, Managing Director, Engineer, and Secretary. Those of our readers who know the glories of York will recognize above the West Tower of York Minster, St. Peter's School, King's Manor, and St. Helen's Church.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Eastern Counties Association at Aldeburgh

Modern Problems in an Old Setting

At first glance, it appears almost like desecration to discuss (let alone to bring into operation) the extreme modernity of present-day gas practice in connection with the ancient Borough of Aldeburgh. Yet that is what the Eastern Counties Gas Engineers and Managers' Association did last week, when, on May 21, they met there under the Presidency of Mr. C. R. FOWLER, of Leiston.

In reality, of course, gas accommodates itself so completely to its surroundings that its newest uses and appliances in no wise detract from the charm which is age. And this is well, for age is Aldeburgh's glory, and any form of "make-up" which would result in disguising this age would be fatal. Unpretentious to a degree, Aldeburgh possesses an indefinable charm which captivates all who would seek to know it. The percentage of those who return after having once visited the place must therefore be very high, and some of those who were there for the first time last week will certainly be among the number to go again.

When to Aldeburgh's natural charm be added the cordial welcome by the President, the generous hospitality of the Chairman and Directors of the Leiston and Aldeburgh Gas Companies, fine weather at all material times, and catering by the management of the Brudenell Hotel which left nothing whatever to be desired, one would assume a meeting of outstanding merit; and this, indeed, it was. Hospitality was also extended to the Association by the Mayor and Corporation, who placed the Moot Hall at their disposal for the business proceedings. This meant a good deal, for the Moot Hall, which stands almost on the beach, with only a few yards between it and the sea, is Aldeburgh's proudest possession. While the exact date is unknown, it is said that "it must have been built some time early in the sixteenth century, when the town was at the height of its prosperity." So much for the age of Aldeburgh. The chief feature of this Hall, which is two storeys high, is a large room on the upper storey, which is reached by an external stair, and is used as the Council Chamber to this day. Here it was that the President, before a crowded audience delivered his Address and the formal business was transacted.

In his Address Mr. Fowler gave an interesting sketch of the history of the Leiston and Aldeburgh gas undertakings, and developments which have been carried out, particularly during the last ten years—or, roughly speaking, during the time that the undertakings have been controlled by the British Gas Light Company. As a matter of fact, the British Gas Light Company obtained the Leiston concern as the first of their East Anglian acquisitions in 1926, following with the Aldeburgh Gas Light Company two years later. Unfortunately, it has been necessary, through the pressure of Institution papers, &c., to hold over the Address, and the other business, until next week's issue.

Luncheon at the Brudenell Hotel.

The meeting over, a group photograph was taken outside the Moot Hall, and thereafter members and visitors, to the number of about 150, proceeded to the Brudenell Hotel, where they were the guests at luncheon of the Chairman and Directors of the Leiston and Aldeburgh Gas Companies—Mr. Henry Woodall, M.Inst.C.E., the Chairman, presiding.

The hosts were toasted enthusiastically, at the call of Mr. Frank Prentice, who said that some thirty years ago he was called in to look at the old Leiston Gas-Works, which at that time had nothing to recommend them. In connection with the new works, however, there was a totally different story to tell. Mr. Woodall had been a good friend to him personally, and was a very important influence in the Gas Industry, particularly throughout the Eastern Counties.

On rising to respond, Mr. Henry Woodall first of all thanked the Mayor for his presence—remarking that those who managed gas undertakings were always pleased to have civic representatives among them. It was very gratifying to him (Mr. Woodall) to welcome the visitors on behalf of the British Gas Light Company, and also to support their President, his old friend, Mr. C. R. Fowler. Mr. Fowler and he had worked together now for nearly twenty years, and each year he held Mr. Fowler in increased respect, on account of his loyalty, his energy, and his ability. The Leiston Works, of course, were quite small, but it seemed to him to be fitting that the Association should occasionally visit these smaller undertakings. Personally, he felt convinced that the very best training for a man was to start by being manager of a small works. The British Gas Light Company controlled a number of undertakings, the largest of which was just about one thousand times bigger than the smallest, and one of his greatest pleasures as Chairman of the Company was to be able to promote to bigger works men who had done well in small ones. While on the subject of small works, Mr. Woodall made complimentary reference to Mr. D. B. Parkinson's 1934 Gold Medal Institution Paper on "Modernizing Small Gas Undertakings." He said he felt sure when they saw the Leiston Works later on in the afternoon they would agree that these works did great credit to Mr. Fowler, and he hoped they would not regard as a waste of time this visit to one of the smaller undertakings.

Proposing "The Town and Trade of Aldeburgh," Mr. F. B. Richards well summed up the views of all in the remark that the impression made upon him was one of peace, beauty, and interest. He congratulated the Mayor, and everyone who was responsible for the care they were taking of the great gift which they had inherited from their forefathers. The Mayor (Mr. S. H. Lewer), replying, agreed that in the County of Suffolk there were to be found more rural charm and more interesting buildings than in most other parts of England.

The next toast was "The Eastern Counties Association," proposed by Mr. A. L. Holton, who referred to the excellent manner in which the Industry had come through the late period of depression, and asked, if it could do so well at such a time, what should it not be able to do in an era of increasing trade like the present? In the course of his acknowledgment, the President referred to the pleasure they all felt at having with them that day some members who had been connected with the Association from very early days. He instanced Mr. Prentice, Mr. Troughton, and Mr. Keable.

The remaining toast, that of "The Visitors and Press," was submitted by Mr. G. A. Mallett, who voiced the gratitude of the Industry for the great work done by the British Commercial Gas Association. The responses were by Councillor W. P. Jackson, President of the B.C.G.A., and Mr. Alfred Harrison, Director of Walter King, Ltd.

Orford and Framlingham.

During the proceedings just outlined, the large number of ladies of the party had been most enjoyably entertained by a visit to Orford Castle and luncheon at the Dolphin Inn, Thorpeness, where nearly 50 sat down.

Then, in the afternoon, the members and ladies joined in a delightful drive to Framlingham—an admirable choice, which enabled the visitors to become still further steeped in antiquity, for Framlingham goes back into the dim and distant past. Like Aldeburgh, too, Framlingham is proud, and not ashamed, of its age. It glories in the ruins of an ancient and majestic castle. The outer walls, 8 ft. thick, still standing, testify to the prowess of our ancestors as builders, but, alas, as the guide-book tells us, "the materials of the apartments of former magnificence have been utilized for the erection of a workhouse and almshouse for the reception of the poor of the parish, which will lead the moralist to reflect, perhaps with pain, at least with humility, on the fickleness of all human grandeur."

Here tea was served, and some time was spent in the sunshine on the greensward, before beginning the journey

back, during which the compact and well-ordered gas-works at Leiston were visited, under the guidance of the President.

The Association Dinner.

But even when Aldeburgh was again reached, the day was not yet ended, for there remained the Association dinner at the Brudenell Hotel, at which some 100 sat down in the evening, with the President in the chair. This was followed by another toast list, interspersed with first-rate items of entertainment, and 11.30 was reached ere the time arrived for singing "God Save the King."

After the Loyal Toast, that of "The British Gas Light Company" was most appropriately honoured, for their kindness as hosts during the day had been exceptional. The proposer, Mr. George Wright, pointed out that the Company commenced business 113 years ago, and still continued to progress from strength to strength. They controlled 37 gas undertakings, and it must be very gratifying to the present Board of Directors to see that the policy they had been following for many years was now being copied by others. The welfare of the employees was one of the Company's first considerations, and this was a most important point. On behalf of all who had taken part in the day's proceedings, he expressed a deep sense of appreciation of the hospitality that had been showered upon them.

Mr. Graham Wilkin, a Director, responded to the toast as representing the British Gas Light Company. He briefly traced the Company's policy of expansion, and added that in almost, if not in all, cases in which they had acquired control, the consumers had largely benefited from the taking over of their concerns.

"Our Guests" was the toast entrusted to Mr. George Dixon, who declared that everyone in the room deeply appreciated the honour conferred by His Majesty upon their leader, Sir David Milne-Watson. Among the large number of guests, he referred with pleasure to the presence of Mr. R. N. Webb, President of the Manchester District Association of Gas Engineers.

Mr. W. Ross Taylor, of the National Gas Council, and M.P. for the Division, said they all owed a debt to the Hon. Secretary and Treasurer, Mr. W. C. Chapman, for having made the arrangements which had resulted in so successful a day. Proceeding, he remarked that the report of the Joint Committee on Gas Charges had been a triumph for the Gas Industry, and it was certainly a triumph for the National Gas Council. One of the first results had been that it had brought into the Council a Company who had remained long outside, and whose accession made the Council nearly 100% representative.

The health of the President was drunk with acclamation, at the call of Mr. J. H. Troughton, and Mr. Fowler made feeling acknowledgment.

Golf Competition.

In the evening of the day preceding the meeting, the second fixture of the Annual Golf Competition was played off on the excellent course of the Aldeburgh Golf Club, where the long stretches of vivid coloured gorse and golden broom are, perhaps, on occasion, admired more by the onlooker than by the man with the club. The competition was for the Association Golf Challenge Trophy and replica, presented by Mr. Douglas W. Turner, and three other prizes provided by Mr. Fowler, who invited the players to supper after the game, and was cordially thanked for his kindness, on the proposition of the Secretary. The weather was glorious, and the game was thoroughly enjoyed by all who took part in it.

The competition resulted as follows:

CARDS HANDED IN.

	Gross.	Handicap.	Net.
J. Simpson	81	− 3	= 78
H. Ruggles	97	−18	= 79
G. Dixon	99	−18	= 81
L. F. King	92	−11	= 81
E. W. King	100	−18	= 82
G. W. Wright	99	−13	= 86
W. D. Cheshire	93	− 7	= 86
C. E. Wright	102	−14	= 88
C. E. Byrt	107	−18	= 89
H. Saville	121	−20	=101
G. G. Clarke	126	−24	=102
W. W. Townsend	133	−20	=113

Illuminating Engineering Society

Annual General Meeting

By permission of the Institution of Mechanical Engineers, the Annual General Meeting of the Illuminating Engineering Society was held in the Hall of the Institution, Storey's Gate, St. James's Park, S.W., on May 19. The chair was taken by the President, Mr. A. Cunnington.

In presenting the report of the Council for the past session, the President drew attention to some features of special interest. The first of these concerned the formation of special sections, which he thought was a very valuable extension of the work of the Society, and they recorded their particular thanks to the gentlemen who had been responsible for these sections. In connection with the Industrial Lighting Section the President made special mention of Mr. A. R. McGibbon. There had also been a rather unusual development of the social side of the Society's activities, and in this connection the President mentioned the projected visit to Paris, which might one day become a regular summer meeting. Finally, Mr. Cunnington made reference to the Statutory Requirements for Lighting in Factories. Opportunity had been taken in the annual report to record an outstanding event of the past session—viz., the inclusion in the Factory Bill now before Parliament of a general requirement of adequate and suitable lighting in factories and workshops. It was fitting that this long deferred step should be taken during the period of office of the present Chief Inspector of Factories, Mr. D. R. Wilson, a Past-President of the Society, who has done much to create a general recognition of the benefits of good industrial lighting.

The financial report was presented by Mr. E. Stroud, who drew attention to the fact that the amount received in subscriptions was approximately £180 more than last year. On the other hand, as was expected, the expenditure of the Society had more than kept pace with this increase in revenue. Taken as a whole, the administration expenses were not widely different from those of the previous session, the extra outgoings being due to printing of the transactions and provincial meetings.

The adoption of the report and accounts was moved by Mr. H. Buckley, who thought the report very substantial proof of the progress of the Society during the past session. Nevertheless, the Society could not become really healthy until the provincial sections were going well. The special sections were very essential at the present time owing to the greatly increased membership, which there was no better means of getting than by a bright active society. He observed the expenditure had been kept within the revenue of the Society, and he thought the increased expenditure had been money well spent, for which they had obtained good value. He asked the members to pass a very hearty vote of thanks to the President and Officers of the Society; the wise guidance the President had given them during the past session was deserving of the gratitude shown in the report. He also made special mention of the Hon. Secretary, Mr. J. S. Dow.

Dr. Angus had very great pleasure in seconding the proposition, which was carried with acclamation. Mr. Dean moved and Mr. Smith seconded the re-appointment of the Auditors, Messrs. J. Ward & Co., for the ensuing year.

After the Meeting there followed an interesting symposium on Coronation lighting and floodlighting. The first contributor was Mr. R. O. Ackerley. Mr. Ackerley was followed by Mr. Stroud. The great part gas had played during the celebrations was described, with the aid of coloured slides, by Mr. J. G. Clark, of the B.C.G.A., who drew attention to the large number of war memorials which had been gas floodlighted, and having shown many fine examples, he passed on to deal with the floodlighting of parks and gardens for which gas is pre-eminently suitable. These parks and gardens included in addition to St. James's Park—more or less familiar to the majority of members—a very fine piece of work done by the Plymouth Gas Department in the treatment of Devonport Park. Church floodlighting followed, several examples coming from Stockport, Fowey, and South London. A particularly interesting feature was Melrose Abbey. Specimens of decorative gas lighting were provided by slides of the Mill Bridge, Leamington, and a showroom of the South Metropolitan Gas Company. The final speaker was Mr. T. Catten.

In the ensuing discussion, Mr. Percy Good made some striking observations on the floodlighting and decoration of London during the Coronation, describing the floodlighting of some buildings as "disgraceful," since their character was lost owing to the use of monochromatic light. Gas flares were a most effective form of decorative lighting, but Mr. Good thought it a pity that most of the flares on bollards lost their complete effectiveness by being under a bright gas lamp which had to be left on. Where these flares had been used away from bright light sources, as on the roof of the R.A.C. building, they were most impressive.

Flues for Instantaneous Gas Water Heaters

by
LEOPOLD FRIEDMAN
(Chief Engineer and Manager Technical Department, Ascot Gas Water Heaters, Ltd.)

From a Paper read before members of the Midland Junior Gas Association at a meeting held on Thursday, April 1—Mr. F. A. JENKINS (Leamington), the President, in the chair.

(*Continued from p. 425*)

The procedure for arriving at the correct cross-sectional area for a given output and various heights of main flue was the same as for the experiments for galvanized-iron flues already described. Fig. 21 shows the CO_2 contents curves for a water-cooled flue. From these it is possible to see that, for a completely safe installation, the limiting case is the flue of 100 mm. diameter, whereas for a galvanized-iron flue it was 90 mm. We can therefore be safe in assuming that an addition of 20% on to the values for the cross-sectional area obtained for a galvanized-iron flue will give the correct figure for the case under consideration. These revised figures are given in figs. 22, 23, and 24.

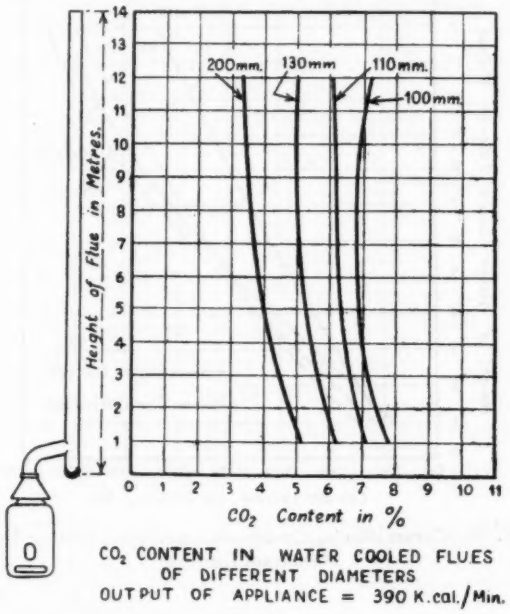

Fig. 21.

[*The above diagram was inadvertently inserted in last week's section of Mr. Friedman's Paper instead of the correct Fig. 19 shown below.*]

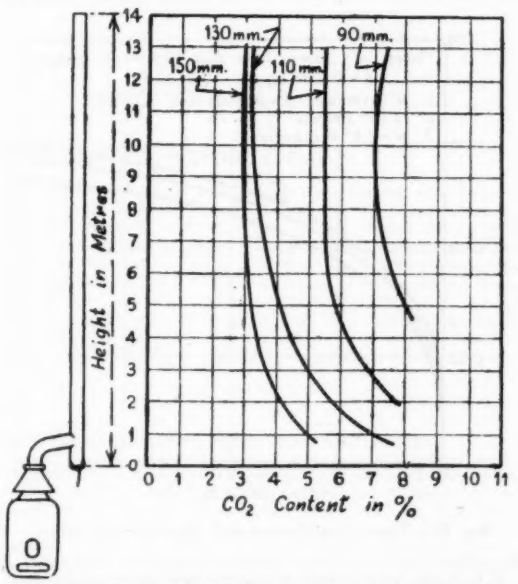

Fig. 19.—Curves giving CO_2 Content in Flues of Different Diameter Output of Appliance = 390 K.cal./Min.

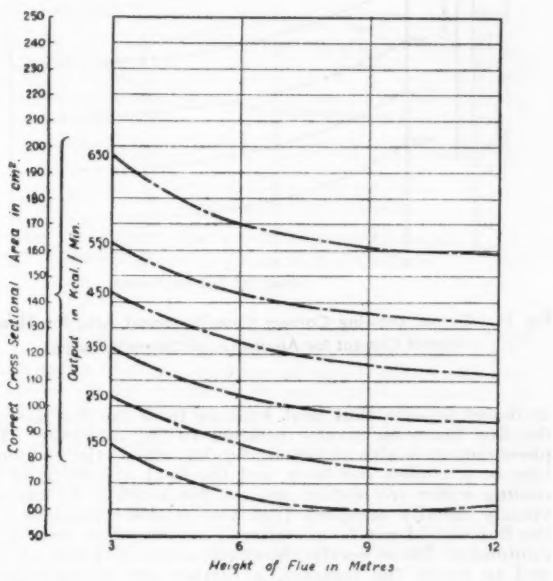

Fig. 22.—Curves showing Correct Cross Sectional Area for Flues of Glazed Earthenware for Appliances of Different Output.

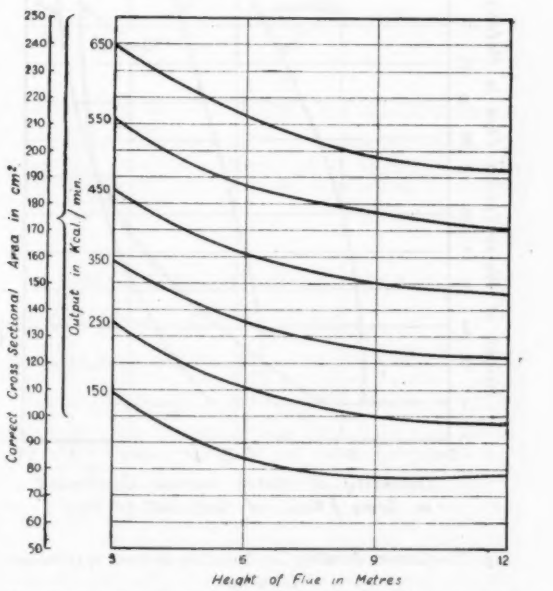

Fig. 23.—Curves showing Correct Cross Sectional Area for Flues of Brick or Masonry for Appliances of Different Output.

In a gas water heater connected to a flue of high thermal

capacity and operating intermittently, condensation is bound to occur, and this condition will be chronic and not temporary. Fig. 25 shows the liberation of condensate for main flues of different diameters in grammes per K.Cal. absorbed by the cooling water. The result is surprising,

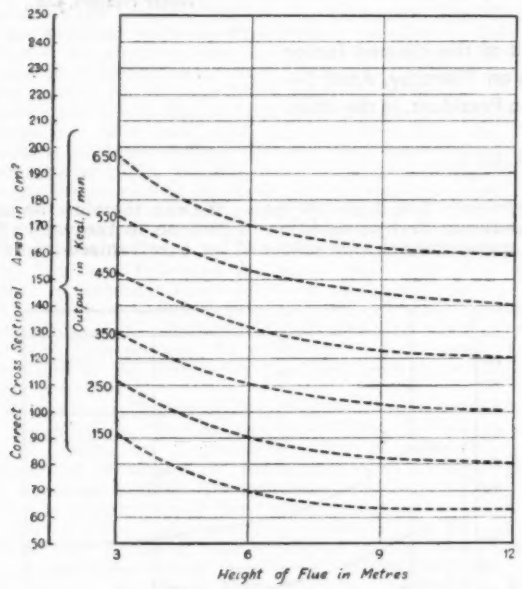

Fig. 24.—Curves showing Correct Cross Sectional Area for Flues of Asbestos Cement for Appliances of Different Output.

as it can be seen that heat transfer from the flue gases to the flue bears an inverse relation to the diameter. This phenomenon is also shown by fig. 26, where the condensation in grammes per hour and the heat absorbed by the cooling water are plotted against flue height. It was previously usually accepted that the cross-sectional area of the flue should not be excessive if condensation were to be minimized. These results, however, contradict this theory, and to verify the findings, a further set of experiments

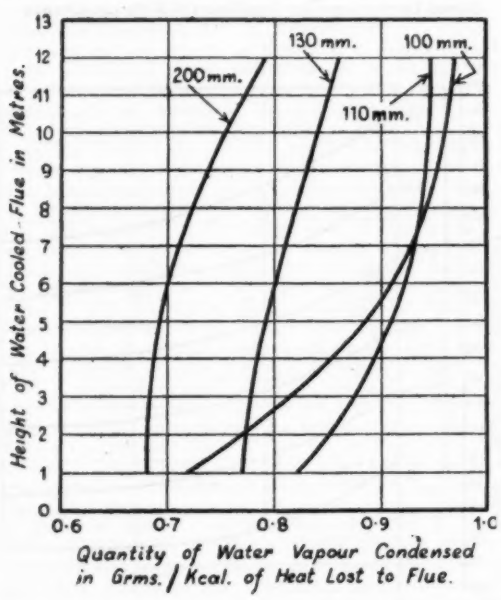
Height of Water Cooled Flue in Metres.
200 mm.
130 mm.
110 mm.
100 mm.
Quantity of Water Vapour Condensed in Grms./Kcal. of Heat Lost to Flue.

Fig. 25.—Curves showing Condensation in Flues of Different Diameter.

were made on two separate installations. In one case, the gas water heater was connected to a water-cooled flue with a diameter of 110 mm., while in the other it was connected to a flue of 200 mm. diameter. The loading of the heat-transferring surfaces of the flue was the same in each case. These experiments confirm the results obtained previously, as shown in the following table:

TABLE 3.

Height in Metres	1	5	9	12
Gr. condensation per hour for 110 mm. diam	522	1,978	3,000	3,480
Gr condensation per hour for 200 mm. diam.	508	1,450	2,030	2,760

The law underlying these curves is obscure, and it is impossible to obtain a mathematical expression. The curves in fig. 25 were the result of sets of experiments, and the mean values were taken. The only explanation that

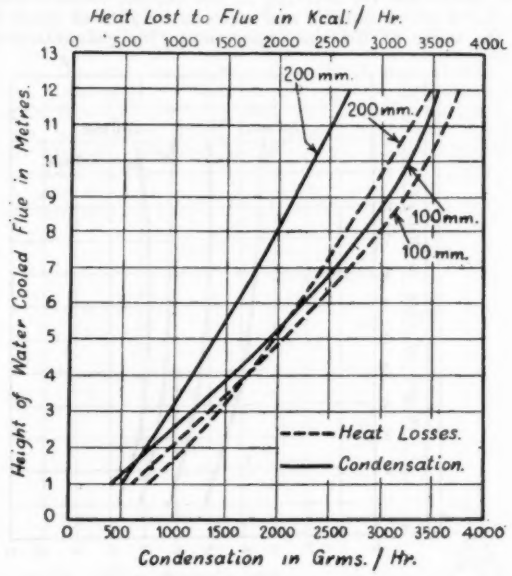

Fig. 26.—Curves showing Condensation and Heat Losses for Flues of Different Diameter.

I can offer is that heat transfer from the flue gases to the flue wall increases more rapidly owing to the reduction of the static film caused by the higher velocities in flues of small cross-sectional area than to the effect of increase of the heat-transferring services in large flues. The cross-

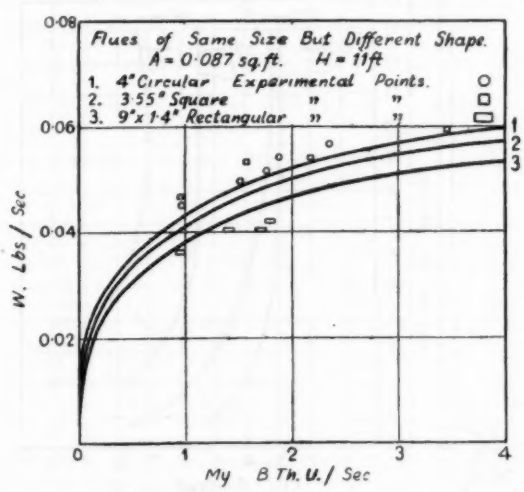
Flues of Same Size But Different Shape.
A = 0·087 sq.ft. H = 11ft
1. 4" Circular Experimental Points.
2. 3·55" Square
3. 9"x1·4" Rectangular
W. Lbs./Sec
My B Th. U./Sec

Fig. 27.—Theoretical Curves with Experimental Points.

[Reproduced by the kind permission of Messrs. C. A. Masterman and T. G. Noble, from a Paper, "Gas Fire Flues and Ventilation."]

sections obtained above are for galvanized-iron flues, the coefficient of friction of which is low. They must therefore be corrected if other materials are used. The general laws, however, are identical for all materials, which make the figures obtained of great value for constructional pur-

poses. Correction factors were deduced from experiments, and are given below:

Brickwork.	40% additional cross-sectional area on values obtained for galvanized-iron flues (not water cooled).
Circular earthenware flues glazed inside and outside.	8% additional cross-sectional area on values obtained for galvanized-iron flues (not water cooled)
Asbestos cement and similar synthetic compositions.	15% additional cross-sectional area on values obtained for galvanized-iron flues (not water cooled).

The shape of the flue also has an effect on the cross-sectional areas. The ideal shape is circular, as in this case the largest area is obtained for the smallest perimeter, thereby reducing frictional resistance. Opinion on the degree to which elongation affects the relative capacity of flues differs,* fig. 27 and fig. 28. In my opinion the proportion of the two sides of the elongated flue should not exceed 2 : 1.

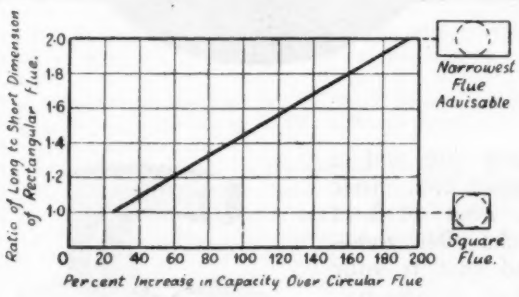

Fig. 28.

[Reproduced by the kind permission of the McGraw Hill Publishing Company from "The Gas Engineers' Handbook."]

When considering the materials for flues, it is important to examine the question of condensation very carefully, especially where built-in flues are used. It would be interesting to ascertain in what way condensation can be avoided or minimized, and if the addition of excess air can solve this problem. In the first instance, certain theoretical deductions were made. A water heater with a known input was assumed to be operating with gas, the constituents and therefore the products of combustion of which were known. Theoretical values for excess air, corresponding flue gas temperatures and dew point were calculated. The values for the latter two were plotted against the ratio of theoretical air requirements and actual air requirements, for the assumed test gas, fig. 29. From

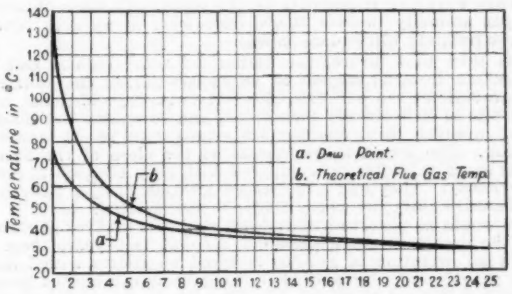

Fig. 29.—Curves showing Effect of Excess Air on Air Temperature and Dew Point of the Flue Gases.

this it can be seen that the temperature of the flue gases fall more rapidly than the dew point, which leads one to the conclusion that the addition of excess air would have no influence on the quantity of condensation formed. In view of the fact, however, that in practice, condensation has been known to be reduced by the addition of excess air, experiments were carried out with a water-cooled flue installation of the type already described. Two heaters with similar outputs of 320 K.Cals. per minute were tested. In one case, the pull in the flue was due only to the temperature difference of the flue gases and the outside air, while in the other, the pull in the flue was produced by means of a fan.

(To be continued.)

*"Gas Fire Flues and Ventilation," by C. A. Masterman and T. G. Noble, 1932.
The Gas Engineers' Handbook, 1936.

Athletic and Social

Edinburgh Gas Department Picnic.

The first annual picnic of Edinburgh Corporation Gas Department was held at Broomiehall Park, Juniper Green, last week, when over 500 were catered for. The company was made up of employees and employees' children. The Gas Department football team committee attended to the sports arrangements, and a selected committee attended to the catering, the Secretary being Mr. John Joyce. Some of the prizes were given by Mr. J. Jamieson, Engineer and Manager, and Mr. Melvin, Assistant Engineer. Other gifts were subscribed by the staff through a prize draw. Mrs. Melvin presented the prizes to the various winners.

How Leamington Celebrated the Coronation.

To celebrate the Coronation the employees of the Leamington Priors Gas Company and their wives were entertained by the Directors of the Company to tea at the Town Hall on Thursday, May 13.

A company of 490 assembled and was presided over by the Chairman, Dr. Harold Mason, who was accompanied by Mrs. Mason, Miss Mason, and Mr. Clayton. Supporting were the Mayor, Alderman C. H. Southern (a Director of the Company), and the Mayoress Mrs. Southern, Mr. R. S. Ramsden (a Director, General Manager, and Engineer) and Mrs. Ramsden, Mr. Joseph Stiles (Auditor), Mr. F. A. Jenkins (Assistant Engineer and Sub-Manager), Mr. W. H. Reed (Engineer and Manager of the Warwick Gas Company, and formerly of the staff at Leamington), and Mr. I. S. Prater (Secretary) and Mrs. Prater.

Sir John Ferguson Bell and Mr. W. A. Coleman (Directors) were unavoidably absent.

Following an excellent tea there was community singing and a programme was provided by Messrs. H. B. Vause, Percy Pike, George Wilderspin, Jnr., H. Hancock, R. Haydon, H. Norton, and the Serenaders Band.

Gas Undertakings' Results

Imperial Continental Gas Association.

The report of the Directors of the Imperial Continental Gas Association for the 113th year of its commercial activity, ended March 31, 1937, states that availing itself of the extended powers assured to it by its 1936 Act, the Association has taken an important interest in Edmundsons Electricity Corporation, Ltd. The Association's Subsidiary and Allied Companies have all made satisfactory profits. The Cokeries du Brabant has resumed dividend payments. The statement of accounts to March 31, 1937, shows that the balance to the credit of the profit and loss account was £427,038, add balance brought forward of £496,045, total available for appropriation £923,083. Out of this balance there has been paid on the capital of £5,600,000 an interim dividend of 4%, less income-tax £170,800, leaving £752,283. The Directors now recommend the payment of a final dividend of 6%, less income-tax at 5s. in the £, making a total dividend of 10%, less tax, for the year, £252,000, leaving a balance to be carried forward of £500,283. The Directors report with deep regret the death, on May 12, of Sir Henry Birchenough, Bt., G.C.M.G., who had served on the Board in the offices of Director, Deputy Chairman and Chairman over a period of 38 years.

Associated Gas and Water Undertakings

Ordinary General Meeting

The Fourth Ordinary General Meeting of Associated Gas and Water Undertakings, Ltd., was held on May 19 at Incorporated Accountants' Hall, Victoria Embankment, London, W.C. Mr. W. Lees Stenning, M.B.E., J.P. (Chairman of the Company), who presided, said that during the year they had acquired 95% of the capital of the Chesham and District Gas Company; 92% of the capital of the Farnham Gas and Electricity Company; 93% of the Ordinary stocks of the Guildford Gas Light and Coke Company; 94% of the Ordinary stock of the Haywards Heath District Gas Company, and 93% of the capital of the Yorktown (Camberley) and District Gas and Electricity Company.

They were now responsible for the supply of 1,930 million cu.ft. of gas annually to over 70,000 consumers in an area covering approximately 676 square miles.

As they were aware, the authorized share capital had been increased from £1,000,000 to £3,500,000 during the year so as to provide for the purchase of interests in the additional undertakings he had already mentioned, and to enable the Board to deal promptly with any further acquisitions in the immediate future. The issued share capital at the close of the financial year stood at £1,181,225 compared with only £563,685 12 months previously. They had also created £500,000 of 3½% Redeemable Debenture stock, of which £363,700 was allotted.

It would be observed that, to the balance of £29,615 standing to the credit of share premium account last year, there had been an accretion of £62,332 received on shares issued during the period under review. Following their established practice they had debited to this account the heavy stamp duties on the increased share capital and Debenture stock, the expenses in connection with those items, the discount on Debenture stock issued, and a liberal sum written off their investments in subsidiary companies. The total sum thus disposed of was £67,198, leaving £24,749 still in hand.

On the credit side of the balance-sheet, the value of their holdings in subsidiary companies (after writing off £21,593) showed an increase of over 200%; the actual figures being £2,145,127, compared with £705,131 in the previous accounts.

Last year he had mentioned that, subsequent to the closing of the books, their investments in undertakings other than subsidiaries had risen to nearly £50,000. Later, however, opportunities presented themselves for the disposal of two holdings at considerable advantage, so that their assets under this heading to-day showed little change. The profit on these transactions amounting to £3,260 had been utilized to write down still further the value of the remaining investments, and had not been brought into the revenue account.

The amounts owing to sundry creditors and by sundry debtors to the Company naturally increased with the expansion of business, but the sum of £59,290 shown as due to the Company on March 31 last was exceptional. It had since been reduced to a figure which may be regarded as normal.

Turning to the revenue account, dividends and interest on investments at £42,667 (after deduction of income-tax) showed an increase of £27,762 over 1935-36, and income from other sources £10,795—an increase of £9,008. In this connection the Chairman pointed out that, although the balance-sheet showed the total capital expenditure to March 31 last, most of the additional acquisitions had been made during the closing months of their financial year, and therefore the total revenue of £53,462 fell far short of that to be derived in a full period, which is estimated to exceed £90,000 (after deduction of tax).

On the debit side the outstanding features were an increase of £6,550 paid in bank interest and a new item, Debenture interest, £4,613. There had also, of course, been an increase in the expenses of administration, but not proportionate to the growth of the Company. Finally, the profit available for distribution at £37,621 compared with £14,139 for the previous year. The report of the Directors set out their recommendations as to the disposal of this sum, and if the payment of a dividend upon the Ordinary shares at the rate of 5% per annum, less tax, were approved, the amount carried forward would be £10,271, compared with £1,590 brought in.

Returning to their own affairs, it would be appreciated that with the rapid growth of the Company an enormous amount of work and responsibility had been thrown upon their Managing Director, Mr. Bennett. He had dealt with matters of finance, conducted the negotiations for the acquisitions of subsidiaries, and subsequently supervised their management. His colleagues felt this to be a burden which it was unfair to expect him to sustain. They therefore decided recently to appoint a General Manager to relieve him of the details of administration and thus permit him to devote himself to those matters of primary importance which continually arose. Their choice had fallen upon Mr. J. R. W. Alexander, who would take up his duties in about a month's time. Mr. Alexander had for a number of years occupied the position of Secretary of The Institution of Gas Engineers with conspicuous success.

Speaking as their Chairman, Mr. Stenning had for some time past been conscious that the rapid expansion of the Company had been making greater demands on his health and occupying more time than he could devote to the duties which that position entailed. He therefore proposed to vacate the chair at an early date, and was pleased to know that, with the cordial approval of his colleagues, their Managing Director, Mr. Bennett, was prepared to take up this added responsibility. This did not imply any slackening of his interest in the progress of the Undertaking, and as Deputy-Chairman he hoped he might still render useful assistance to the Company.

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SECURE ECONOMY-THROUGH LASTING SECURITY

Carew Wilson

South-Western Gas and Water Corporation

Record of Steady Progress

The Coal Situation

Mr. S. J. Ingram's Speech

The Third Annual General Meeting of the South-Western Gas and Water Corporation, Ltd., was held on May 19, at 9, Clements Lane, London, E.C.

The REPRESENTATIVE of Messrs. Close Brothers, Ltd., the Secretaries, read the notice convening the meeting and the report of the Auditors.

Before proceeding to consideration of the accounts, the CHAIRMAN (Mr. S. J. Ingram, M.Inst.Gas E.) referred to the absence from the meeting of Sir Francis Goodenough, who has recently undergone a serious operation, but who is now making a good recovery.

The Chairman, proceeding, said: I think you will agree the accounts disclose a record of steady, although not spectacular, progress and development.

In order to secure funds for the purpose of expansion and to take advantage of favourable money conditions, the capital of the Corporation has, during the year, been increased by the issue of £25,226 4½% Preference shares and £110,000 3½% Debentures.

The Directors have realized certain investments held by the Corporation, resulting in a profit, which has been utilized in creating a reserve fund. The Directors feel sure that the policy of creating this reserve fund will meet with the approval of the shareholders. At the same time I would point out that there is not the same need for a large reserve fund in the case of a holding company as in that of an ordinary trading company. In our case most of our constituent companies have reserve funds or large carry forwards which are quite adequate for this purpose.

The Year's Activities.

During the past year considerable extensions have been carried out in certain of our undertakings. The physical linking up of the Shaftesbury Undertaking with Gillingham is now complete, and the whole of the gas supply in this area is now manufactured at our Gillingham Works. The site at Shaftesbury is now being cleared and offered for sale. This scheme has already been productive of considerable economy in manufacture and distribution. At Midsomer Norton the gas mains have been carried out to Paulton, a flourishing suburb of the town, and premises are being rapidly connected to the mains.

Continuing their policy of absorbing the smaller undertakings into larger neighbouring companies, the Beaminster Company will shortly be acquired by the Crewkerne Undertaking.

Development of the Sales Organization.

Your Board have paid special attention during the past year to the intensification and development of the sales organization of our various constituent Companies. Many of these undertakings, however, are too small to be in a position to organize and carry out any elaborate scheme of propaganda, but under our policy of placing these smaller undertakings in the charge and under the oversight of their larger neighbours, they have the advantage of calling on them for advice and guidance and, if necessary, the services for a limited period of canvassers, gasfitters, &c.

In this connection, I would invite your attention to a scheme initiated by the corporation, and which has proved remarkably successful. Briefly, the scheme is one in which any modern gas appliances, such as cookers, fires, water heaters, gas irons, and the like may be obtained on hire-purchase terms for the period of hire purchase. In the case of the cooker the period is seven years, and in the case of other appliances it depends on the cost of the appliance, but in every case the hire-purchase terms are the same—namely, sixpence per week, including fixing and maintenance.

This scheme has been very successful in attracting a fresh class of consumer and in securing the replacement of old black cookers and fires by enamelled appliances of modern design. The policy of making purchases or arranging special terms on behalf of the constituent companies has been continued and extended, the considerable benefit derived therefrom being passed on to the companies without any deductions whatsoever.

I now anticipate that you will expect me to say a few words on the coal situation. I am afraid, however, that at this juncture it would not be wise for me to do so at any length. I will, however, say that your Directors have watched the situation with very grave concern, as the cost of coal enters very largely into the accounts of our various companies.

Changed Position in the Coal Industry.

That the Gas Industry had every sympathy with the lot of the coalminer in his distressful plight a year ago was made abundantly clear when a voluntary increase of 1s. per ton on contract prices was gladly agreed to. Now, however, the situation has changed and profits in the coal industry have made a spectacular advance. In these circumstances the Gas Industry as a great public utility enterprise might reasonably expect at least equitable treatment. Instead it would seem that we are to appear bound hand and foot in our negotiations for supplies, with no voice at all in determining either the quality or price of coal, or even whether we shall be supplied with any coal at all. This is indeed a situation which any board of directors of a public utility undertaking charged with important obligations to the public cannot regard with unconcern.

Promising Outlook.

As to the outlook for the future, I have been actively engaged in the Gas Industry for many years, and have studied its fortunes with more than passing interest. Now in its latest phase and in respect of this Corporation I can say with every confidence:

1. That never in our history has the use of gas in its varied applications been in more popular favour.
2. Never was the Gas Industry better equipped or more eager to take advantage of this fact than at the present.
3. Never before was public opinion—and I think I may add now also the Government—so well disposed to the Gas Industry and anxious that so many disabilities under which it has laboured shall be removed, than at the present. In proof read again the recent report of the Joint Parliamentary Committee on Gas Charges.

The only doubtful feature in the outlook for the moment is the coal situation, but I have sufficient confidence in the sagacity and good will of those dealing with this situation to believe that all the difficulties which at present appear so dark and menacing will in due course disappear or be dealt with satisfactorily.

The Chairman concluded his remarks with an expression of appreciation of the work done by the local Boards of Directors and the staffs of the constituent companies.

The report and accounts were unanimously adopted and the dividends recommended were approved.

The Director retiring by rotation, Mr. C. L. Rosewarne, J.P., C.C., was re-elected.

The Auditors, Messrs. Deloitte, Plender, Griffiths, & Co., were re-appointed, and the proceedings then terminated.

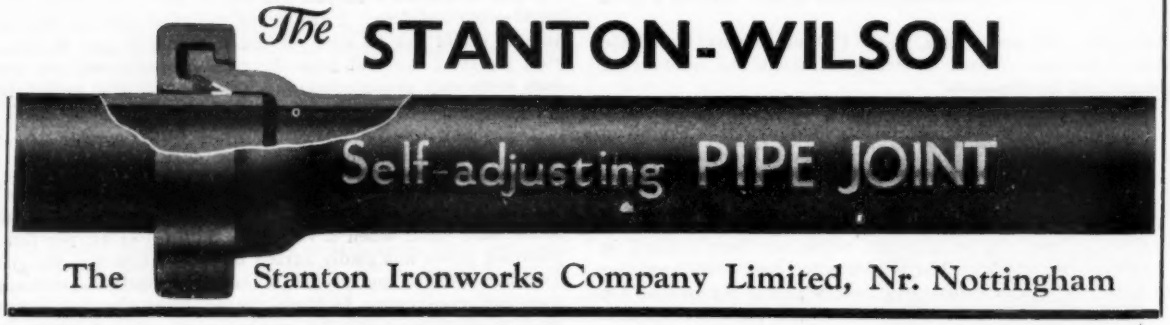
Traffic Vibration

Rigid or Self-adjusting Joints?

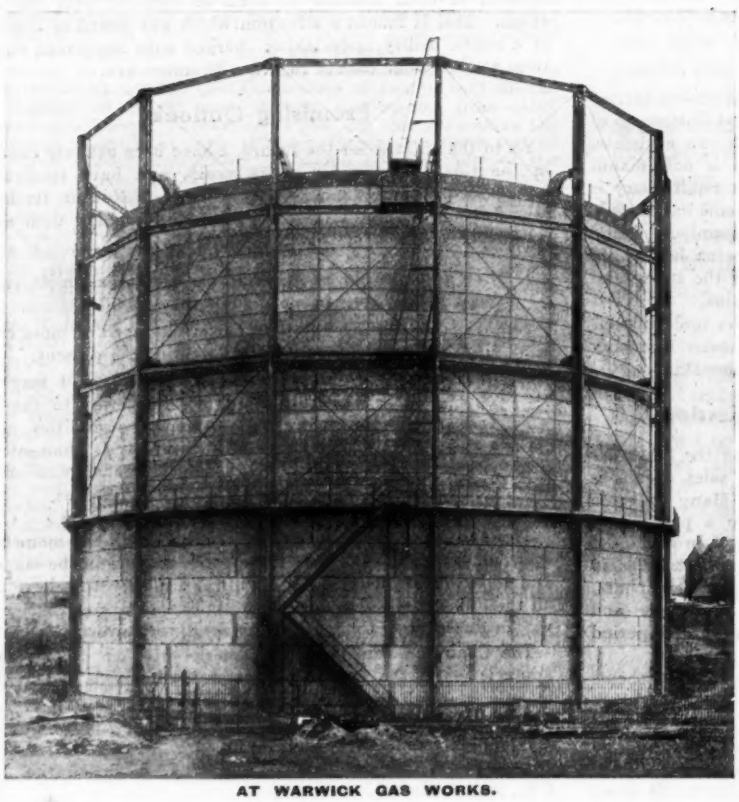
Not many of the problems brought into being by the remarkable growth of road transport during the last decade are capable of easy solution.

There is at least one exception, however. For instance, though much has been heard of the danger caused to historic buildings by traffic vibration, the harmful effects of such vibration on water and gas mains are not so apparent. To water and gas engineers responsible, however, for the maintenance of these essential public services, this was a very real problem until a few years ago, for rigidly-jointed mains could not be expected to withstand the severe vibration caused by modern conditions.

Some six years ago the Stanton Company introduced the Stanton-Wilson Self-adjusting pipe joint to overcome this and similar difficulties. That it has successfully done so is proved by the fact that more than 1,500 miles of Stanton-Wilson mains have now been laid by over 750 public authorities.



The Stanton Ironworks Company Limited, Nr. Nottingham



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Gas Markets and Manufactures

Stock Market Report

(For Stock and Share Lists, see later pages)

Much more confidence was displayed on the Stock Exchange towards the close of last week and, with the resumption of buying, prices which previously had been drastically marked down began to move sharply in the other direction. Home rails benefited for several reasons—*e.g.*, the increased traffic receipts, the news of the companies' application for an advance of about 5% in fares, and the increased hopes of a settlement of the labour dispute in the coalmining industry. The industrial section began to get busy again, and the previous reactions have given the genuine investor an opportunity of "getting in" at more reasonable prices. Interest is returning to the goldmining section, where the present comparatively low prices show good yields on last year's dividends. Oils and rubbers also produced some good features. The prospects for the current week appear decidedly brighter.

The return of activity to the more speculative sections eased up the volume of business in the Gas Market last week, though prices closed firm and there were a few upward movements. In the Official List, Shrewsbury ordinary, which had been somewhat undervalued, rose 7 points to 142½. This Company has distributed a dividend of 6¾% each year since 1928-29, and the yield on the current price at this rate works out at £4 14s. 8d.%. Two of the fixed-interest stocks of the Gas Light Company hardened a point, and Croydon sliding-scale also closed 1 point up at 144½. The margin of South Metropolitan ordinary narrowed to 3, leaving a net loss of 1 point. The only change of note at the Provincial Exchange was a further rise of 1½ in Liverpool ordinary, while in the Unofficial List Southgate and District 7% maximum stock closed 2½ points higher at 142½.

The accounts of the Imperial Continental Gas Association for the year to March 31 show an income of £599,906 (against £607,003 last year), and a net profit, after income-tax, of £427,038 (against £437,770). The Directors are recommending a final dividend of 6%, making 10% for the year (the same), leaving a substantial carry forward of £500,283 (against £496,045). In the Association's Act of 1936 powers were obtained to extend its activities to this country, and during the year under review nearly £2,000,000 has been invested here. On the dividend announcement the stock rose 5 points to 162½, and at the current rate for the year this gives a yield of £6 3s.%. With the resumption of dividend payments by the Cokeries du Brabant and at least the maintenance of current profits by its other subsidiaries, the prospects for the current year appear good.

Current Sales of Gas Products

The London Market for Tar Products.

LONDON, *May* 24.

The position in the London Tar Products market is as follows:
Pitch, 36s. to 37s. per ton f.o.b.
Creosote, 6d.
Refined tar, 3¾d.
Pure toluole, 2s. 6d.; pure benzole, 1s. 9d.; 95/160 solvent naphtha, about 1s. 8d.; and 90/160 pyridine, about 8s.; all per gallon naked at makers' works.

Tar Products in the Provinces.

May 24.

The average prices of gas-works products during the week were: Gas-works tar, 22s. 6d. to 27s. 6d. Pitch—East Coast, 35s. to 36s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 35s. to 36s.* Toluole, naked, North, 2s. to 2s. 1d. Coal tar crude naphtha, in bulk, North, 8½d. to 9d. Solvent naphtha, naked, North, 1s. 6¼d. to 1s. 6½d. Heavy naphtha, North, 1s. 3d. to 1s. 3½d. Creosote, *ex* works, in bulk. North, liquid and salty, 5d. to 5¼d.; low gravity, 4⅝d. to 4¼d. Heavy oils, in bulk, North, 5d. to 5¼d. Carbolic acid 60's, 3s. 7½d. to 3s. 10½d. Naphthalene, £18 to £20. Salts, 90s. to 95s., bags included. Anthracene "A" quality, 4½d. to 4⅝d. per minimum 40% purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be neecssary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *May* 22.

There is a decided scarcity of all Tar Products with the exception of the heavy distillates. Accordingly business is not extensive.

Crude gas-works tar.—The actual value is 36s. to 37s. per ton *ex* works in bulk.

Pitch.—In the absence of enquiry values remain nominal at 30s. to 32s. 6d. per ton f.o.b. Glasgow for export, and 30s. per ton *ex* works in bulk for home trade.

Refined tar.—A fair volume of new business is being transacted at round 3d. to 3¼d. per gallon free on rails for export, and 3½d. to 3¾d. per gallon *ex* works in buyers' packages for home trade.

Creosote oil.—Supplies are quite scarce and prices are firm as follows: Specification oil, 5½d. to 5¾d. per gallon; low gravity, 5¾d. to 6d. per gallon; neutral oil, 5¼d. to 5½d. per gallon; all *ex* works in bulk.

Cresylic acid.—Only small quantities are available, which readily command the following prices: Pale, 97/99%, 4s. 5d. to 4s. 7d. per gallon; dark, 97/99%, 4s. 2d. to 4s. 4d. per gallon; and pale, 99/100%, 4s. 10d. to 5s. 1d. per gallon; all *ex* works in buyers' packages.

Crude naphtha.—Available supplies command 6d. to 6½d. per gallon *ex* works in bulk, according to quality and district.

Solvent naphtha is steady with 90/160 grade at 1s. 4½d. to 1s. 5½d. per gallon, and 90/190 heavy naphtha at 11d. to 1s. per gallon.

Motor benzole is valued at 1s. 4d. to 1s. 4½d. per gallon.

Pyridine.—Prices are nominal at 7s. to 8s. per gallon for 90/160 grade, and 8s. to 9s. per gallon for 90/140 grade.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s. d.		s. d.	
Crude benzole . . .	0 10	to	0 10½	per gallon at works
Motor ,, . . .	1 3½	,,	1 4	,, ,, ,,
90% ,, . . .	1 4½	,,	1 5	,, ,, ,,
Pure ,, . . .	1 8½	,,	1 9	,, ,, ,,

Contracts Advertised To-Day

Benzole Extraction Plant.
Middleton Gas Department. [p. 576.]

Coal.
Atherton Gas Department. [p. 576.]
Caernarvon Gas Department. [p. 578.]
Droitwich Gas Department. [p. 578.]
Hoylake Gas Department. [p. 576.]
Nantwich Gas Department. [p. 578.]

Crude Naphtha.
Lincoln Gas Department. [p. 576.]

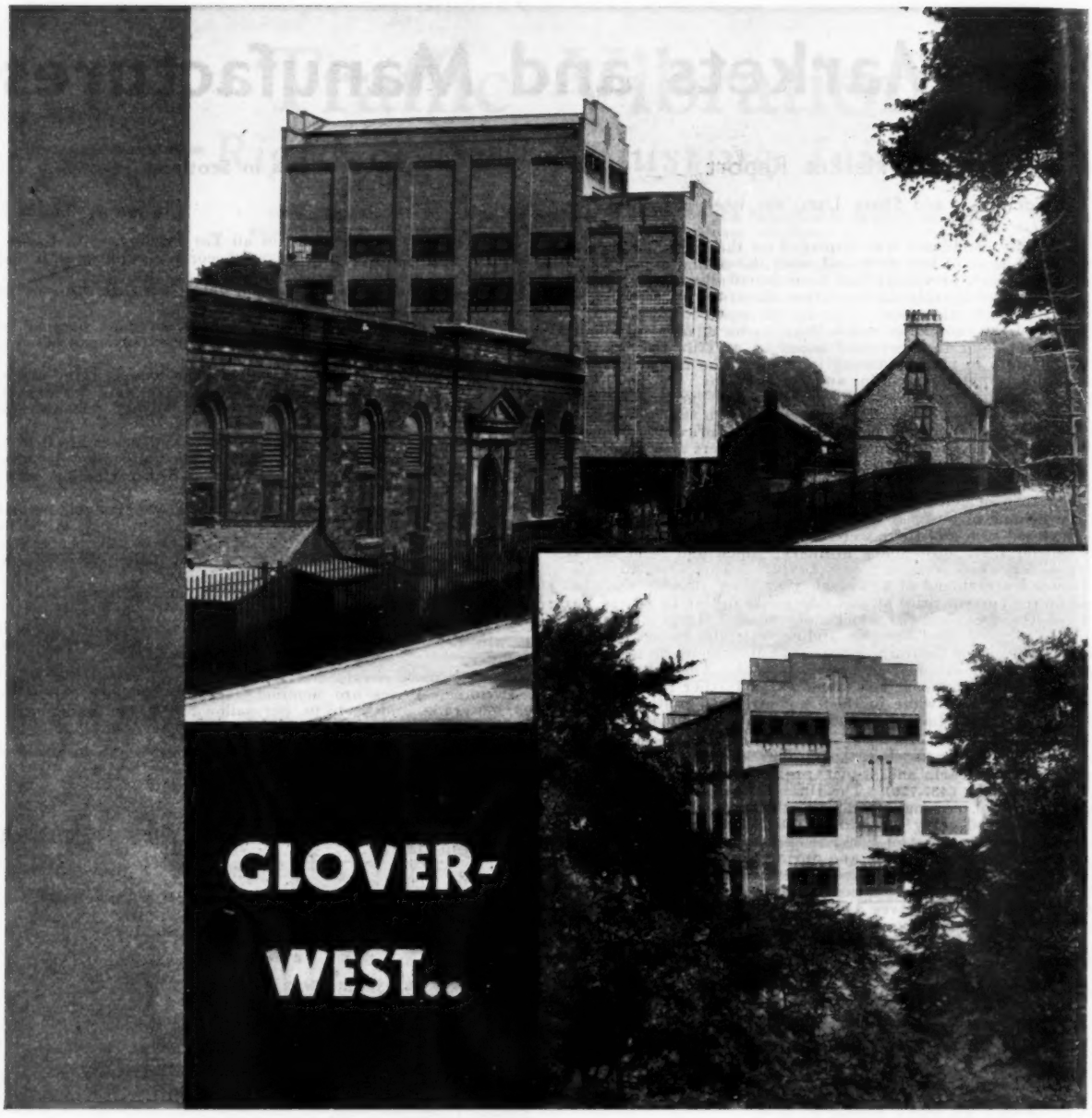
Lime.
Mansfield Gas Committee. [p. 576.]

Mantles.
Birmingham Gas Department. [p. 576.]

Meters.
Mansfield Gas Committee. [p. 576.]

Stoves.
Birmingham Gas Department. [p. 576.]

Tubes and Fittings.
Birmingham Gas Department. [p. 576.]



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STOCK AND SHARE LIST

Official Quotations on the London Stock Exchange

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 21.	Rise or Fall on Week.	Transactions, Lowest and Highest Prices During the Week.
1,767,439	Stk.	Mar. 15	8	8	Alliance & Dublin Ord. ...	170—175	...	...
374,000	,,	Dec. 14	4	4	Do. 4 p.c. Deb. ...	96—101	...	...
558,890	,,	Feb. 15	7	7	Barnet Ord. 7 p.c.	160—165	...	...
300,000	1	Apl. 5	1/4⅛	1/9⅛	Bombay, Ltd.	25/6—27/6	...	...
179,915	Stk.	Mar. 1	9½	9½	Bournemouth sliding scale ...	195—205	...	...
590,407	,,	,,	7	7	Do. 7 p.c. max. ...	161—166	...	164
493,960	,,	,,	5	6	Do. 6 p.c. Pref. ...	133—138	...	...
50,000	,,	Dec. 14	3	3	Do. 3 p.c. Deb. ...	80—85	...	...
262,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	100—105	...	...
335,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	117—122	...	...
357,900	,,	Feb. 15	7½	7½	Brighton, &c., 6 p.c. Con. ...	155—160	...	...
649,955	,,	,,	6½	6½	Do. 5 p.c. Con. ...	138—143	...	140—141
205,500	,,	,,	6	6	Do. 6 p.c. 'B' Pref.	130—135	...	131½
855,000	,,	Mar. 1	7	8	British Ord.	148—153	...	...
100,000	,,	Dec. 14	7	7	Do. 7 p.c. Pref. ...	143—148	...	...
350,000	,,	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	103—108	...	...
450,000	,,	,,	3½	3½	Do. 3½ p.c. Red. Deb.	95—100	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	1—3	...	...
100,000	10	6 Nov.'33	4½	4½	Do. 4½ p.c. Pref. ...	1⅛—3⅛	...	...
150,000	Stk.	Jan. 4	4½	4½	Do. 4½ p.c. Deb. ...	80—85	...	...
626,860	,,	Feb. 1	6	6	Cardiff Con. Ord.	120—125	...	...
237,860	,,	Dec. 14	5	5	Do. 5 p.c. Red. Deb.	107—112	...	...
98,936	1	Apl. 5	2/-	2/-	Colombo Ord.	1⅝—1⅞	...	...
24,510	1	,,	1/4½	1/4½	Do. 7 p.c. Pref. ...	23/—25/-	...	...
739,453	1	Mar. 15	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	17/—19/-	...	...
296,144	1	,,	1/3·30	1/3·30	Do. 8 p.c. Pref.	22/—24/-	...	23/4½
1,775,005	Stk.	Feb. 1	5	5	Commercial Ord.	88—93	...	...
620,000	,,	Nov. 30	3	3	Do. 3 p.c. Deb. ...	73—78	...	75½—76
286,344	,,	Feb. 15	5	5	Do. 5 p.c. Deb. ...	115—120	...	...
807,560	,,	Feb. 15	7	7	Croydon sliding scale ...	142—147	+1	146—147
644,590	,,	,,	5	5	Do. max. div.	109—114	...	...
620,385	,,	Dec. 14	5	5	Do. 5 p.c. Deb.... ...	115—120	...	117
239,000	,,	Feb. 1	5	5	East Hull Ord. 5 p.c....	100—105	...	...
185,355	,,	Feb. 15	6	6	East Surrey Ord. 5 p.c. ...	122—127	...	...
176,211	,,	Dec. 14	5	5	Do. 5 p.c. Deb. ...	113—118	...	117
250,000	1	Nov. 16	6	4	Gas Consolidation Ord. ...	20/—22/-	...	...
250,000	1	,,	4	4	Do. 4 p.c. Red Cum. Pref.	19/—21/-	...	19/6
19,255,284	Stk.	Feb. 1	5⅔	5⅔	Gas Light & Coke 4 p.c. Ord.	25/3—26/3a	...	25/3—25/10½
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max.	80—83	...	...
4,477,106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	100—103	...	101—102½
8,602,497	,,	Nov. 30	3	3	Do. 3 p.c. Con. Deb. ...	80—83	+1	81—83
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	110—113	...	...
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb....	109—112	+1	111—112
700,000	,,	Mar. 1	25/5⅝	3½	Do. 3½ p.c. Red. Deb....	98—101	...	100½
270,466	,,	Feb. 15	6	6	Harrogate New Cons. ...	122—127	...	...
213,200	,,	Feb. 15	6	6	Hornsey Con. 3½ p.c. ...	120—125	...	...
5,600,000	,,	Nov. 2	12	8	Imperial Continental Cap. ...	160—165	+5	156½—164
223,130	,,	Feb. 1	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...	91½
285,242	,,	Mar. 1	8½	8½	Lea Bridge 5 p.c. Ord. ...	160—165	...	...
11,751	,,	Mar. 1	8	10	Maidstone Gas 5 p.c. Cap. Stk.	180—190	...	...
63,480	,,	Dec. 14	3	3	Do. 3 p.c.Prp.Db.Sk.	72—77	...	...
75,000	,,	Nov. 30	†10	†10	Malta & Mediterranean ... Metropolitan (of Melbourne)	150—160	...	...
392,000	—	Apl. 1	5½	5½	5½ p.c. Red. Deb.	98—103	...	...
231,978	Stk.	Feb. 15	5	5	M.S. Utility 'C' Cons. ...	102—107	...	...
968,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	95—100	...	...
360,075	,,	Dec 14	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
148,955	,,	,,	5	†5	Do. 5 p.c. Deb. ...	115—120	...	...
125,000	—	Jan. 4	3½	3½	Do. 3½ p.c. Rd.Rg.Bds.	97—100	...	...
675,000	Stk.	May 3	†6	†9	Montevideo, Ltd.	85—90*	...	87—89
250,000	,,	Feb. 15	7½	7½	North Middlesex 6 p.c. Con.	152—157	...	...
396,160	,,	Feb. 1	5	5	Northampton 5 p.c. max. ...	102—107	...	...
300,000	,,	Apl. 19	†9	†7	Oriental, Ltd....	162—167	...	...
416,617	,,	Dec. 14	8	8	Plymouth & Stonehouse 5 p.c.	165—170	...	...
621,667	,,	Feb. 15	8¼	8¼	Portsmouth & Gosport Cons.	167—172	...	170
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	105—110	...	104½—105½
73,350	,,	,,	...	5	Do. 5 p.c. Pref. ...	112—117	...	...
441,275	1	May 3	1/-	1/1½	Severn Val. Gas Cor. Ld. Ord.	20/6—22/6*	...	...
460,810	1	Mar. 15	-/10½	-/10½	,, ,, 4½ p.c. Cum. Pref.	20/—22/-	...	...
133,201	Stk.	Feb. 15	5	8½	Shrewsbury 5 p.c. Ord. ...	140—145	+7	...
90,000	10	June 8	13½	‡4	South African...	4—5	...	...
1,371,752	1	May 3	1/2⅝	1/2⅜	South East'n Gas. Cn.Ld. Ord.	24-/—26/-*	...	24/9—25/6
871,636	1	Mar. 1	-/10⅜	-/10⅜	Do. 4½ p.c. Red. Cum. Pref.	20/—22/-	...	20/6—21/6
498,818	1	,,	4	4	Do. 4 p.c. Cum. Pref. ...	19/6—21/6	...	19/9
450,000	,,	Feb. 15	4	4	Do. 4 p.c. Deb.	100—102	...	...
150,000	Stk.	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	99—101	...	...
6,709,895	,,	Feb. 1	5	6	South Met. Ord.	107—110	−1	108—109
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf. ...	132—137	...	132
850,000	,,	,,	4	4	Do. 4 p.c. Irred. Pf. ...	97—100	...	97⅞—98⅛
1,895,445	,,	Dec. 14	3	3	Do. 3 p.c. Deb. ...	74—79	...	78
1,000,000	,,	Jan. 4	5	5	Do. 5 p.c. Red. Deb....	107—112	...	...
1,543,795	,,	Feb. 1	6	6	South Suburban Ord. 5 p.c....	122—127	...	...
512,825	,,	,,	5	5	Do. 5 p.c. Pref....	112—117	...	...
500,000	,,	,,	4	4	Do. 4 p.c. Pref....	95—100	...	100
888,587	,,	Dec. 14	5	5	Do. 5 p.c. Deb....	115—120	...	...
250,000	,,	,,	4	4	Do. 4 p.c. Deb....	98—103	...	...
427,859	1	May 3	9⅜	1/2⅜	S. Western Gas & Water Ord.	19/—21/-*	...	...
160,523	1	Apl. 19	-/10⅛	-/10⅛	Do. 4½ p.c. Red. Cum. Pf.	20/—22/-	...	21/6—21/7½
110,000	Stk.	Dec. 14	4	4	Do. 4 p.c. Red. Deb. ...	98—103	...	...
750,541	,,	Feb. 1	5	5⅓	Southampton Ord. 5 p.c. ...	111—116	...	114
148,836	,,	Jan. 4	4	4	Do. 4 p.c. Deb.	98—103	...	...
350,000	,,	Feb. 15	5⅓	5⅓	Swansea 5½ p.c. Red. Pref. ...	110—115	...	...
106,000	,,	Jan. 4	6⅓	6⅓	Do. 6⅓ p.c. Red. Deb. ...	98—101	...	...
94,000	,,	,,	3⅓	3⅓	Do. 3⅓ p.c. Red. Deb. ...	95—100	...	...
1,076,490	,,	Feb. 15	6⅔	6⅔	Tottenham and District Ord.	137—142	...	141
409,835	,,	,,	5⅓	5⅓	Do. 5⅓ p.c. Pref....	123—128	...	...
62,235	,,	,,	5	5	Do. 5 p.c. Pref. ...	110—115	...	...
371,850	,,	Nov. 30	4	4	Do. 4 p.c. Deb. ...	98—103	...	...
373,939	,,	Feb. 15	7	7	Uxbridge, &c., 5 p.c. ...	142—147	...	...
133,010	,,	,,	5	5	Do. 5 p.c. Pref. ...	110—115	...	...
1,371,138	,,	Feb. 1	7	7	Wandsworth Consolidated ...	142—147	...	145⅛—146⅝
1,620,615	,,	,,	5	5	Do. 5 p.c. Pref ...	113—118	...	...
500,000	,,	,,	33/4	4	Do. 4 p.c. Pref. ...	95—100	...	...
1,343,964	,,	Dec. 14	5	5	Do. 5 p.c. Deb. ...	117—122	...	118½
383,745	,,	,,	4	4	Do. 4 p.c. Deb.	98—103	...	...
558,342	,,	Feb. 1	7	7	Watford and St. Albans Ord.	142—147	...	145½
200,000	,,	,,	5	5	Do. 5 p.c. Pref. ...	110—115	...	...
200,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	123—128	...	...
200,000	,,	Dec 14	4	4	Do. 4 p.c. Red. Deb.	97—102	...	...
100,000	,,	,,	3½	3½	Do. 3½ p.c. Red.Deb.	95—100	...	...

a.—The quotation is per £1 of Stock. * Ex div. † Paid free of income-tax. ‡ For year. ⅓ Actual.

Stock and Share List continued overleaf.

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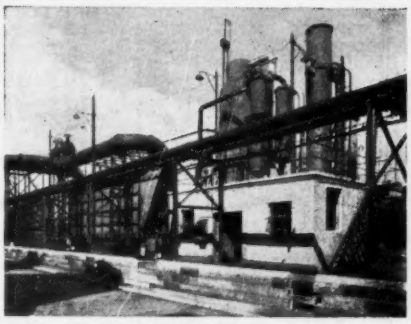

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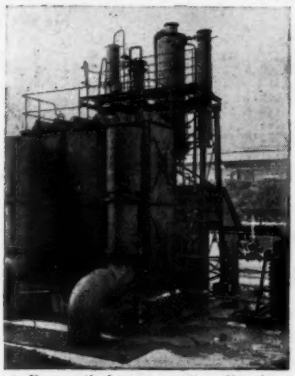

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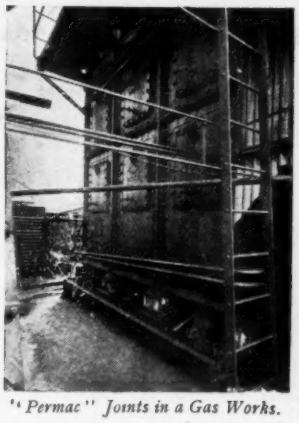

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Stocks Officially Quoted on Provincial Exchanges

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations. May 21.	Rise or Fall on Week.	Transactions, Lowest and Highest During the Week.
BRISTOL EXCHANGE.								
347,756	Stk.	Feb. 1	5	6	Bath Cons.	121—123	...	...
1,667,250	,,	Feb. 15	5	5	Bristol, 5 p.c. max.	114—116	...	...
120,420	,,	Dec. 14	4	4	Do. 1st 4 p.c. Deb. ...	101—103	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	101—103	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	122—125	...	..
274,000	,,	Mar. 1	5	5	Newport (Mon.) 5 p.c.max. ...	103—108	...	...
13,200	12	Mar. 15	7	8	Pontyp'l Gas & W. 10 p.c. 'A'	13½—14½	...	...
13,600	10	,,	5	6	Do. 7 p.c. 'B'	12—12½	...	...
40,000	10	,,	5	6	Do. 7 p.c. 'C'	12—12½	...	...
140,778	Stk.	Feb. 1	5	5	Weston-super-Mare Cons. ...	112—113	...	...
64,338	,,	Dec. 14	4	4	Do. 4 p.c. Deb.	98—101	...	...
33,340	,,	,,	7½	7½	Do. 7½ p.c. Deb.	160—163	...	...
LIVERPOOL EXCHANGE.								
157,150	Stk.	Feb. 1	5	6½	Chester 5 p.c. Ord.	106—111	...	...
92,500	,,	Dec. 14	4½	4	Do. 4 p.c. Pref.	98—102	...	...
36,430	,,	,,	3	3½	Do. 3½ p.c. Deb.... ...	90—95	...	...
41,890	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	99—103	...	...
2,167,410	,,	Feb. 15	6	6	Liverpool 5 p.c. Ord. ...	125½—127½	+1½	...
245,500	,,	Dec. 14	5	5	Do. 5 p.c. Red. Pref. ...	101—106	...	...
306,083	,,	Jan. 4	4	4	Do. 4 p.c. Deb. ...	103—105	...	...
106,280	,,	Feb. 1	10	10	Preston 'A' 10 p.c.	210—220	...	...
188,219	,,	,,	7	7	Do. 'B' 7 p.c.	150—160	...	...
NEWCASTLE EXCHANGE.								
122,577	Stk.	Feb. 1	8	8	Blyth 5 p.c. Ord.	166—168	...	...
732,000	,,	Feb. 15	5	5	Hartlepool G. & W. Cn. & New	125—127	...	...
2,061,315	,,	Feb. 1	5	5½	Newcastle & Gateshead Con.	25.9—26 *a*	...	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	100—102	...	...
776,706	,,	Jan. 4	3½	3½	Do. 3½ p.c. Deb. ...	93—94	+1	...
277,285	,,	Nov. 2	5	5	Do. 5 p.c. Deb. '43...	108—109	...	...
332,351	,,	Feb. 1	6	6	Sunderland 6 p.c. max. ...	139—141	...	...
NOTTINGHAM EXCHANGE.								
542,270	Stk.	Mar. 1	7	9	Derby Con.	155—175	...	...
55,000	,,	Dec. 14	4	4	Do. 4 p.c. Deb.	100—105	...	...
84,750	,,	Feb. 17	5	12	Long Eaton 'A' Ord. ...	...	...	...
50,000	,,	,,	4	10	Do. 'B' Ord. ...	...	...	...
20,000	10	Dec. 14	5	5	Do. 5 p.c. Pref. ...	10—12	...	...
80,000	Stk.	,,	5	5	Do. 5 p.c. Deb. ...	105—110	...	...
SHEFFIELD EXCHANGE.								
10,000	Stk.	Aug. 10	10	10	Great Grimsby 'A' Ord. ...	210—220	...	...
6,500	,,	,,	10	10	Do. 'B' Ord. ...	210—220	...	...
79,000	,,	,,	10	10	Do. 'C' Ord. ...	205—210	...	...
1,806,339	,,	Feb. 15	6	6½	Sheffield Cons.	143—145	...	...
95,000	,,	Jan. 4	4	4	Do. 4 p.c. Deb.... ...	101—104	...	...

Supplementary List of Stocks and Shares not Officially Quoted

202,152	Stk.	Mar. 15	25/-*b*	25/-*b*	Ascot Ord.	102—107	...	...
128,182	,,	Jan. 4	5	5	Do. 5 p.c. Pref.	110—115	...	...
312,083	1	Nov. 16	5	5	Assd. Gas and Water Ord. ...	19/6—21/6	...	21/6
326,071	1	,,	4½	4½	Do. 4½ p.c. Cum. Pref. ...	19/6—21/6	...	...
150,000	Stk.	Mar. 15	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...	97½—97¾
17,000	,,	Feb. 15	8	8	Bognor Orig. Ord. 'A' ...	160—170	...	...
62,210	,,	,,	8	8	Do. New Addl. 'A' ...	160—170	...	...
87,160	,,	,,	7	7	Do. New 7 p.c. max. ...	140—145	...	...
37,440	,,	Feb. 1	10	10	Cam. Univ. & Town 10 p.c.max.	195—205	...	...
125,970	,,	,,	7	7	Do. 7 p.c. max.	137—142	...	...
39,025	,,	,,	5	5	Do. 5 p.c. max.	98—103	...	...
65,000	,,	Mar. 1	7½	8½	Eastbourne 'A' 5 p.c. ...	160—165	...	...
198,000	,,	,,	6	7	Do. 'B' 3½ p.c.	130—140	...	...
112,312	,,	,,	5	5	Do. 5 p.c. Pref.	110—115	...	...
130,000	,,	Dec. 14	5	5	Do. 5 p.c. Deb.	115—120	...	...
24,000	30	Feb. 1	8½	8½	Great Yarmouth 8½ p.c. max.	45—50	...	...
59,400	30	,,	7½	7½	Do. 7½ p.c. max.	40—45	...	...
51,160	Stk.	Dec. 14	5½	5½	Do. 5½ p.c. Deb.... ...	122—127	...	...
152,600	,,	Feb. 15	8	9	Guildford Cons.	190—200	...	...
54,055	,,	,,	5	5	Do. 5 p.c. Pref.	112—117	...	...
68,250	,,	Dec. 14	5	5	Do. 5 p.c. Deb.	115—120	...	...
156,600	,,	Feb. 15	7½	7½	Hampton Court Cons. ...	150—160	...	...
107,960	10	Mar. 15	4	5½	Mid Kent Ord.	9—10	...	...
230,940	Stk.	Feb. 15	10	10	Oxford & District Ord. ...	200—210	...	...
47,112	,,	,,	5	5	Do. 5 p.c. Pref.	110—115	...	...
50,000	,,	,,	6	6	Do. 6 p.c. Red. Pref. ...	112—117	...	...
126,193	,,	May 3	7½	7½	Peterborough Ord.	159—169*	...	...
64,990	,,	Mar. 15	6½	7½	Redditch Ord.	127—137	...	...
166,850	,,	Feb. 15	8	8	Romford Ord.	157—167	...	...
60,000	,,	,,	4	4	Do. 4 p.c. Pref.	97—100	...	...
44,000	,,	Mar. 15	5	5	Do. 5 p.c. Deb.	115—120	...	...
10,950	,,	Mar. 1	8	8	Ryde Ord.	160—165	...	...
136,191	,,	Feb. 15	5	7	Scarborough Ord.	123—133	...	...
27,825	,,	Feb. 1	8	8	Shanklin & Ventnor Cons. ...	158—168	...	...
270,086	,,	Mar. 15	7	7	Slough Ord.	137—142	...	...
21,000	,,	Dec. 14	5	5	Do. 5 p.c. Deb.... ...	113—118	...	...
28,872	1	Nov. 2	5½	5½	S. Midland Gas Cpn. Ltd. Ord.	19/—22/-	...	...
28,866	1	Mar. 15	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	18/6—20/6	...	...
137,730	Stk.	Feb. 15	7	7	Southgate & Dist. 7 p.c. max.	140—145	+2½	145
62,500	,,	,,	5	5	Do. 5 p.c. Pref.	110—115	...	...
117,228	,,	Feb. 15	6	5	Swindon Cons.	108—113	...	...
60,425	,,	Dec. 14	5	5	Do. 5 p.c. Deb.	113—118	...	...
64,380	,,	Dec. 14	5	5	Torquay and Paignton 5 p.c. Pf.	115—120	...	...
750,000	1	Apl. 5	4	6	Utd. Kingdom Gas Cpn. Ord.	20/6—22/6	...	21/6—22/-
936,338	1	May 3	4½	4½	Do. 4½ p.c. 1st Cum. Pref.	20/—22/-*	...	20/9—21/3
674,084	1	Apl. 5	4½	4½	Do. 4½ p.c. 2nd Non-Cum. Pref.... ...	18'—20/-	—/6	18/3—19/- 97¾
600,000	Stk.	Mar. 15	3½	3½	Do. 3½ p.c. Red. Deb. ...	96—99	...	...
130,000	,,	Feb. 15	5	8	Wakefield Ord.	132—137	...	...
81,650	,,	,,	5	5	Do. 5 p.c. max.	103—108	...	...
82,000	,,	Feb. 1	6	6	Weymouth Ord.	103—108	...	...
98,384	,,	Feb. 1	6	6	Wolverhampton 6 p.c. Pref....	125—130	...	...
160,000	,,	Dec. 14	5½	5½	Do. 5½ p.c. Rd. Db	110—115	...	...
370,000	,,	Feb. 15	4	6	York Cons.	105—110	...	...
90,000	,,	Dec. 14	5	5	Do. 5 p.c. Red. Deb. ...	105—110	...	...
133,640	,,	Mar. 1	6½	6½	Yorktown (Cam.) 5 p.c ons.	130—135	...	...
120,000	,,	,,	5	5	Do. 5 p.c. Pref.	110—115	...	...
35,000	,,	Dec. 14	5½	5½	Do. 5½ p.c. Deb.... ...	125—130	...	...

a The quotation per £1 of Stock. *b* Actual for Quarter. * Ex div.

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